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Vol. 42, No. 1, 1959

THE MALAYAN AGRICULTURAL JOURNAL

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Kuala Lumpur.

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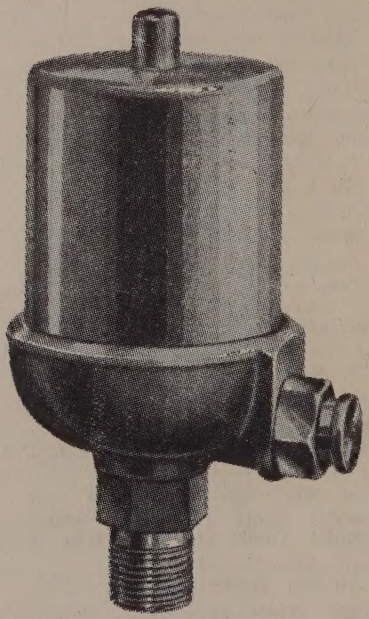

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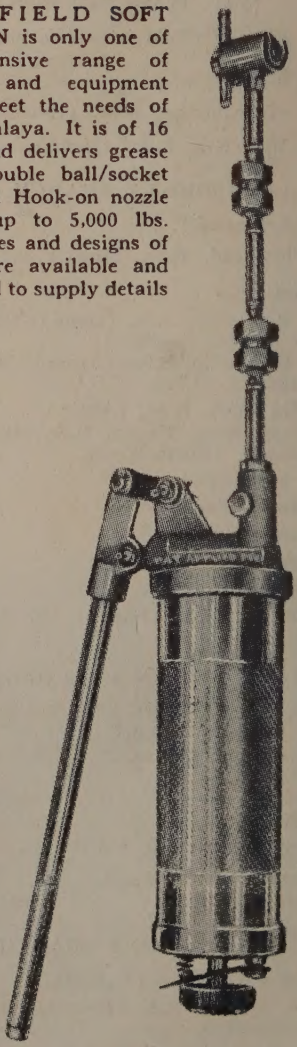

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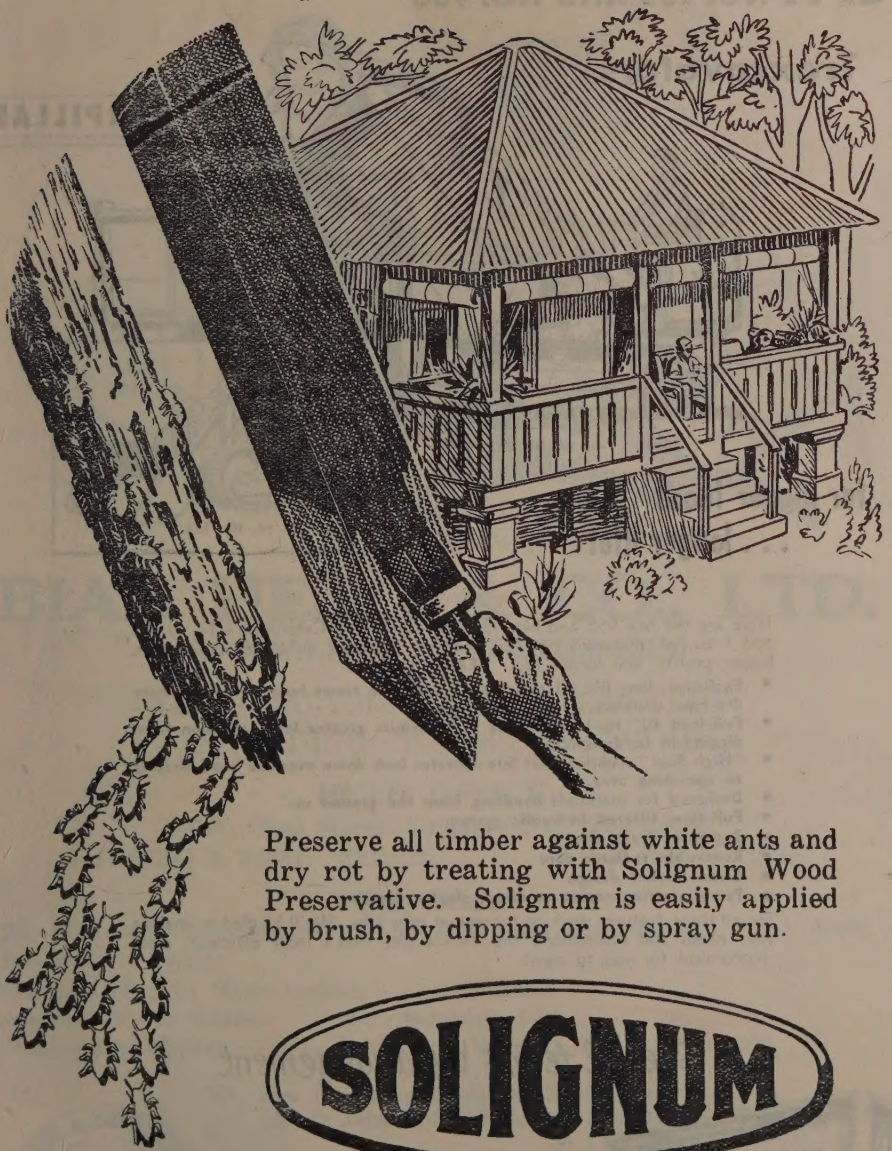

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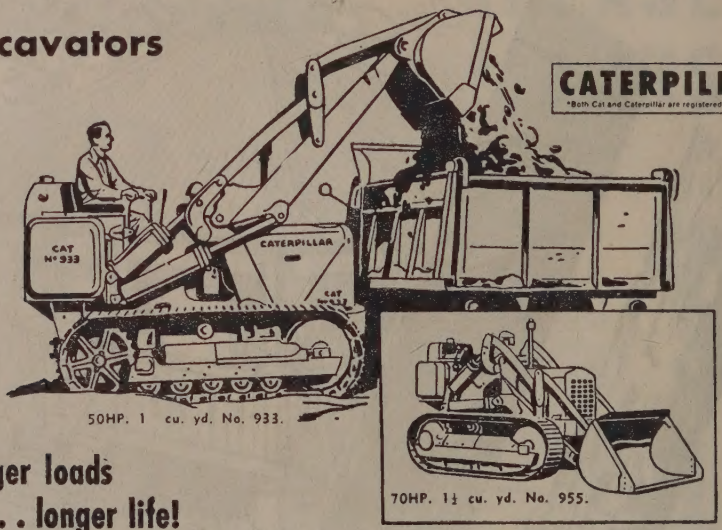

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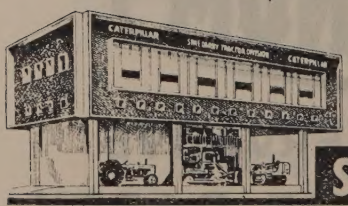

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Erratum

Malayan Agricultural Journal Vol. 41, No. 4, 1958, page 300, "Pests & Diseases" line 2. For "Teersia hexandra" read "Leersia hexandra".

THE

Malayan Agricultural Journal

Edited by the Publications Officer
with the assistance of the Publications Committee.

Vol. 42, No. 1 **1959**

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THE MALAYAN AGRICULTURAL JOURNAL

The Journal which is published quarterly, is designed to present — as far as possible in non-technical terms — the results of the agricultural research, investigation and extension work performed by the Department of Agriculture and it draws attention to the results of work of a similar nature in other countries.

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THE

Malayan Agricultural Journal

Vol. 42, No. 1, 1959.

EDITORIAL

One of the most important measures that can be taken to improve the standard of living of Malaya's farming population, is to encourage the maximum use of the resources available in the countryside. The harvesting of various kinds of padi field fish has long been a means of supplementing rural food resources, and is a useful source of additional income to the farmer or the landlord.

Research has now made possible an increase in the size and weight of at least one padi field fish, the Tilapia, by crossing the local variety with fish from African stock. These hybrid fish have proved capable of growing more quickly and to a greater size under the same conditions than the pure Malayan or African strains of Tilapia.

An article in this issue by Dr. C. F. Hickling, who is a noted British authority on fisheries, describes how these experiments with Tilapia were carried out at the Commonwealth Fish Culture Research Station, Malacca. It remains to be seen if the hybrids can be successfully introduced and naturalised in the padi field ponds and other inland waters in Malaya.

Biochemical and Technological Studies on Pineapple Mr. Conaty has contributed an interesting comparison of the canning qualities of four local pineapple varieties. He alsc describes experiments made on the total recovery of edible matter and its distribution within the fruit. The preparation of pineapple juice and experiments on the production of pineapple juice concentrates are discussed.

Oil Palm Seedling Blight The leaf-spotting disease of oil palm seedlings did not assume serious proportions until two outbreaks occurred in 1952 and 1955. Since then, the disease has spread from Selangor to Johore and Perak and can cause severe damage to nurseries. Mr. Johnston reports on the new disease and describes the symptoms, with suggestions for control measures.

Master Farmers In this issue the "Master Farmers" series is resumed, with a description of a young Malay farmer's success in Central Kedah, contributed by Che Ali Ahmad bin Sulaiman.

SOME BIOCHEMICAL AND TECHNOLOGICAL STUDIES ON MALAYAN PINEAPPLE, WITH PARTICULAR REFERENCE TO THE SINGAPORE CANNING VARIETY

BY

F. N. G. CONATY,

Senior Chemist.

Introduction

The production of Malayan canned pineapple at present amounts to almost two million cases, each containing 48 1 lb. cans. The quantity produced now is less than during pre-war years but there is a big improvement in quality. The pre-war problems and the need for re-organisation of the whole industry after the Japanese occupation, and the events leading to the enactment of the Pineapple Industry Ordinance in 1951 are described by Courtenay (2, 3). Under this ordinance, grading, labelling and marking regulations were drafted with the assistance of this Department at the Canning Research Station, where the foundation was laid for the present Pineapple Inspectorate. Officers of this Department carried out the work of the Inspectorate in the early years up to 1954, when the industry appointed its own staff to continue this work.

The transfer of the work of the Inspectorate to the industry meant that the Department of Agriculure was able to devote more time to pineapple fruit research, particularly as regards quality for canning. A brief account of some of the lines of investigation covered in the past few years are given below.

Canning Quality of Local Varieties

As explained by Dunsmore (4), the four varieties known in Malaya are the Singapore Canning, Selangor Green, Sarawak and Mauritius. The Sarawak is high in both sugar and acid content but because of its poor flavour and conical shape it is of little value, as grown at present, for canning. The Mauritius has the highest sugar content but is low in acidity. It is popular locally as a dessert fruit, mainly because of its sweetness. The Selangor Green is very similar to the Singapore Canning in shape and quality. These two varieties have not the best overall qualities for canning but because they are well balanced as regards sugar and acid content and have good shape and colour of flesh, these form the bulk of the raw material for Malayan canned pineapple. The figures shown in Table I are typical for the analysis of these four varieties when harvested for canning or immediate consumption.

Table I

Analysis of Pineapple Fruit

Variety	Total solids Per cent.	Total Sugars Per cent.	Reducing sugars Per cent.	Acidity as anhydrous citric Per cent.
Singapore Canning -	12.82	9.02	3.57	0.64
Selangor Green -	11.76	9.04	3.39	0.46
Sarawak - -	16.17	13.18	6.5	0.78
Mauritius - -	19.46	15.33	5.22	0.55

Quality of Canned Product at Various Stages of Maturity

It is well known that considerable changes in colour take place in the skin of the pineapple as it progresses from the unripe stage to full maturity. It was therefore decided to carry out experiments in order to compare the quality of the canned product obtainable from these four varieties and also to compare the effect of maturity on the canning quality, in particular with the Singapore Canning variety. In the case of the latter, the fruit is considered still immature when eyes are dark and bracts are grey in colour. According to local standards, the first signs of maturity are shown when the eyes at the base of fruit change to a red colour. When the first three eyes from the base have changed to red the fruit is considered to be 25 per cent mature; when red eyes reach half way up the fruit, maturity is considered to be 50 per cent and so on up to 100 per cent, when all eyes have turned red. This method of classification by colour change was used in this work for all four varieties and samples of each were canned at the immature, 25 per cent, 50 per cent, 75 per cent and 100 per cent stages of maturity.

In all cases the fruit was peeled and cored by machine, then trimmed, cut into segments and packed with 30° Brix sugar syrup into 16 oz. cans. All cans were processed in boiling water (Plate I) and stored for six months before examination. The canned products were then graded according to Canning Research Station grading standards which cover drained weight, colour, texture, flavour and clarity of syrup.

The results showed that in all cases the immature fruit gave a flavourless low grade pack. Fruit at 100 per cent. maturity showed signs of over ripeness and in many cases the product had a fermented taste. For all varieties 50 to 75 per cent. maturity by skin colour was considered satisfactory and in the case of the Singapore Canning 25 per cent. maturity was considered the minimum for export quality standards. These tests showed no difference in quality between the Selangor Green and Singapore Canning. The Mauritius is remarkable because of its bright golden colour over a wide range of maturity but the canned product is poor in flavour, also the fruits are small in size and uneconomic for production purposes. The Singapore Canning and Selangor Green gave the best overall result.

Relationship Between Skin Colour and True Fruit Maturity, Singapore Canning Variety

Sugar and acidity, as in the case of most other fruits, are con-

sidered the two most important ingredients in the composition of the pineapple. The ratio of soluble solids to acidity gives a figure which is known as the true maturity. The bulk of the material in the soluble solids is sugars and the examination of many samples showed that the average difference between the per cent soluble solids and total sugars is 2.4 for this variety. Fruits were examined at each of the skin colours, from immature up to 100 per cent. maturity. For each test 50 fruits weighing 3 to 4 lb. each were selected from a particular area and a separate analysis done for each fruit. The fruit was peeled, cored, trimmed and a section cut lengthwise throughout the peeled fruit, was used for analysis. The sample was macerated with an equal quantity of water in a Waring blender and the soluble solids determined by refractometer. The acidity was determined by direct titration of a weighed quantity of the pulp, using phenolphthalein as indicator and calculated as per cent anhydrous citric acid. The results of the maturity figures obtained have been averaged and are shown in Table II.

Table II

Skin colour	Maturity = $\frac{\text{Soluble solids}}{\text{acidity}}$
Grey bracts. dark eyes	14.32
25 per cent. red eyes	14.7
50 per cent. red eyes	15.22
75 per cent. red eyes	15.88
100 per cent. red eyes	20.83

These figures show a fairly regular increase up to 75 per cent maturity and then a marked rise with full maturity. It is stated, however, in a report (10) on a similar experiment carried out in French Guinea, that the relationship between skin colour and true maturity of the Cayenne variety can vary with season and fruit size.

Recovery of Total Edible Matter From Local Varieties

The bulk of the Malayan canned fruit, as elsewhere, is packed in the form of slices, cubes, segments and other such regular cut pieces. The amount of such material which can be obtained from pineapple depends largely on the size and shape of the fruit. Small, narrow, or cone shaped fruit gives a small recovery (Table III.) The Singapore Canning and Selangor Green are normally square shaped and fruits weighing 3 to 4 lb. measure about 5 inches in diameter. Experiments were conducted to find the total amount of clean edible material which could be recovered from local varieties.

At the time of these experiments no suitable Sarawak fruit was available, but in the case of each of the other three varieties, fruits of about the same weight were selected. All samples were peeled and cored by machine, but trimming of the cylinders of peeled fruit and skin eradication was done by hand. All available edible matter was carefully scraped from the skins. The results are shown in Table III. The edible matter from the various parts of the fruits was weighed

separately for each sample and Table IV shows the average distribution of this material throughout the fruit.

Table III

Recovery of Total Edible Matter.

Variety	No. of Fruits examined	Weight ozs. Average	Diameter Average	Edible Matter Average Per cent.	Waste Average (including core) Per cent.
Singapore Canning	35	65.1	above 5"	68.5	31.5
Singapore Canning	40	45.1	4½" to 5"	62.4	37.6
Selangor Green -	40	44.2	—	60.0	40.0
Mauritius - -	200	28.3	—	54.2	45.8

Table IV

Distribution of Edible Matter.

Variety	Peeled, Cored, Trimmed, Fruit Per cent.	Eradicated Pulp		Eye Trimmings From Peeled Fruit Per cent.	Total Edible Matter Per cent.
		Tops, Tails, Per cent.	Shell Pulp Per cent.		
Singapore Canning -	31.1	8.3	26.7	2.4	68.5
Singapore Canning -	29.8	8.6	20.0	4.0	62.4
Selangor Green -	27.7	7.4	19.8	5.1	60.0
Mauritius - -	29.1	7.6	15.8	1.7	54.2

As regards edible matter, the Selangor Green and Singapore Canning compare favourably with other varieties. The following figures are given by Home and Miller (6) and are shown in Table V for comparison.

Table V

Edible Material in Various Pineapple Varieties.

Variety	Weight of Fruit (Oz.)	Edible Portion Per cent.	Per cent. Waste
Abachi	40	65.3	34.7
Spanish	59	59.3	40.7
Cayenne	78	62.8	37.2
Red Ceylon	58	57.0	43.0
Egyptian	29	50.0	50.0
Golden	55	65.4	34.6
Puerto Rico	46	67.0	33.0
Euville	66	57.5	42.5
Prince Albert	44	61.3	38.7
Sugar Loaf	38.7	57.3	42.7
Rothschild	40.5	63.5	36.5
Wild	23.5	50.0	50.0

Use of Edible Material For Canning

Due to the peculiar physical characteristics of the fruit, it is not possible to extract economically on a commercial basis all the edible material. The amount used for canning in many factories is, in fact, less than 50 per cent of the edible matter available. With the Singapore Canning and Selangor Green varieties the eyes penetrate deeply into the flesh and with fruits of 3 to 4 lb. weight it is necessary to peel to a

depth of 5/8 inch in order to remove all "eye" material. Fruit may be peeled more lightly but this necessitates excessive trimming of eye matter from the cylinder giving the type of pack peculiar to Malaya known as "spiral cut". The machines used for scraping the pulp attached to the skin are known as eradicators; these are usually a permanent fixture on the Ginaca machine which is basically a peeler and corer.

Variation in Quality Throughout Edible Portion, Singapore Canning Variety

It is known that the soluble solids of many fruits are unevenly distributed throughout the individual fruit thus giving a variation in quality throughout the fruit itself. It was decided, therefore, to examine various sections of the Singapore Canning Variety in order to find if there was any variation in quality. This involved the analysis of sections throughout the width and height of the fruit.

Chemical Composition of Core, Central Portion of the Fruit and Shell Pulp.

In preparing samples for analysis the tops and tails were removed and discarded. The fruits were hand peeled to a depth of 3/4 inch and then the core was removed and pulp eradicated from the outer skin or shell. This gave the three parts required, i.e., eradicated pulp, core and the central portion surrounding the core.

Twelve fruits weighing 3 to 4 lb. each and all between 25 to 50 per cent maturity by skin colour were selected and the three parts of each fruit were separated, macerated with an equal quantity of water and analysed for soluble solids, total solids, total sugars and acidity. The soluble solids and acidity were determined by the methods already described and sugars by the Lane—Eynon volumetric method. For total solids a standard procedure was adopted whereby the pulp was partially dried, at first on a water bath and finally in an oven at 105°C. The results of the analysis for each fruit is shown in Table VI. The percentage of core was also recorded.

These figures show (Fig. I) that the sugar content of the core and its surrounding pulp are about the same. The sugar in the pulp beneath the skin is considerably lower than in the rest of the fruit. The core is notable for its low acidity and explains why this is usually considered the sweetest part of the fruit. The core amounts to about three per cent of the total fruit weight.

Similar experiments carried out in French Guinea also showed[5] that the sugar is highest in the portion surrounding the core but in their fruit the eradicated pulp was slightly better than the core.

Distribution of Sugars and Acids Throughout the Height of the Singapore Canning variety at Various Stages of Maturity.

It was shown earlier that the fruit ripens from the base upwards and it was decided to measure the amount of sugar and acid in the peeled

Table VI

Chemical Composition of Different Parts, Singapore Canning Variety.

Sample No.	Fruit Weight (Oz.)	Proportion of Core to Whole Fruit Per cent.	Central Pulp				Pulp Beneath Skin				Core			
			Soluble Solids ° Brix	Total Solids Per cent.	Total Sugars Per cent.	Acidity Anhydrous Citric Per cent.	Soluble Solids ° Brix	Total Solids Per cent.	Total Sugars Per cent.	Acidity Anhydrous Citric Per cent.	Soluble Solids ° Brix	Total Solids Per cent.	Total Sugars Per cent.	Acidity Anhydrous Citric Per cent.
1	56	3.7	10.4	11.54	8.68	0.52	8.1	8.21	5.57	0.48	10.2	13.48	8.05	0.20
2	46	2.6	12.1	13.63	9.79	0.78	9.4	10.16	7.00	0.63	10.7	12.84	8.08	0.32
3	58	3.6	12.1	13.29	9.62	0.68	8.7	9.67	6.37	0.54	10.7	13.55	8.19	0.23
4	56	3.1	12.7	14.00	10.53	0.82	9.1	9.72	6.73	0.63	10.7	13.28	8.16	0.29
5	46	3.4	11.0	12.03	8.32	0.75	8.7	10.01	6.37	0.57	10.4	13.48	7.80	0.30
6	50	2.9	12.7	13.69	10.27	0.77	8.1	8.58	5.70	0.58	12.1	14.43	10.03	0.32
7	58	3.1	9.4	9.86	7.05	0.73	6.7	7.93	4.78	0.57	8.7	12.02	6.98	0.30
8	45	3.5	12.1	14.25	9.64	0.76	9.4	9.56	7.10	0.57	11.3	14.04	8.26	0.30
9	58	2.7	10.4	10.31	6.81	0.53	8.1	7.67	5.29	0.49	10.4	11.49	6.90	0.20
10	55	2.9	10.7	11.34	8.56	0.68	8.1	9.04	6.14	0.52	10.7	13.54	8.76	0.33
11	51	3.3	11.0	12.57	8.53	0.62	8.1	7.94	5.80	0.49	10.7	13.38	8.42	0.21
12	53	2.9	11.3	12.74	9.22	0.77	8.1	8.53	5.95	0.67	10.7	14.71	9.02	0.28
Average	53	3.14	11.33	12.44	8.92	0.70	8.38	8.92	6.07	0.5€	10.61	13.35	8.22	0.27

fruit at various sections throughout its height and at each of the four stages of maturity from 25 to 100 per cent by skin colour. 30 fruits all about the same weight were selected for each stage of maturity.

After removing the tops and tails, each fruit was peeled and cored by machine then trimmed of any adhering foreign matter. The clean cylinders thus obtained were cut into approximately four equal sections at right angles to the core axis. The section nearest the base of the original fruit was called No. 1, next was No. 2, then No. 3 and finally No. 4 for the top section. To cover all four maturities a total of 120 fruits was examined, giving 480 samples to be analysed for sugars and acidity by the methods described earlier. The results of these analyses have been averaged and are presented in Table VII.

Table VII

Analysis of Horizontal Sections of Pineapple Fruits.

Section	25% Maturity		50% Maturity		75% Maturity		100% Maturity	
	Total Sugars Per cent.	Acidity Anhydrous Citric Per cent.	Total Sugars Per cent.	Acidity Anhydrous Citric Per cent.	Total Sugars Per cent.	Acidity Anhydrous Citric Per cent.	Total Sugars Per cent.	Acidity Anhydrous Citric Per cent.
1	9.21	0.66	10.31	0.70	11.48	0.75	11.31	0.62
2	8.63	0.64	10.64	0.68	10.50	0.80	10.69	0.59
3	8.10	0.63	9.20	0.63	9.82	0.79	10.16	0.54
4	6.57	0.61	7.94	0.63	8.62	0.75	9.42	0.54

These figures show that the acidity is evenly distributed throughout the four sections (Fig. II). In all cases the sugar is higher in the bottom than in the top section and there is little variation in this factor throughout the four stages of maturity. It can be assumed that the bottom half of the fruit is better in quality than the top half.

According to Miller and Hall (7) the total soluble solids in the Natal variety decreased also from the base of the fruit towards the top. They also found that the ascorbic acid and bromelin activity were highest in the top sections and decreased progressively towards the base of the fruit. Further evidence of the relationship between maturity and bromelin activity is given by Tonkara (11) who found that this enzyme becomes less active as the fruit becomes more mature.

Pineapple Juice

After machine peeling, more than 50 per cent of the total edible matter remains attached to the outer skin. In factory operations some of this is recovered in the form of pulp by the use of eradicators. Complete recovery is not always practised, as otherwise an excessive amount of "eye" and other foreign matter enters the pulp. Using light eradications a clean pulp can be obtained suitable to pack as pineapple crush,

FIGURE I

Section showing Distribution of Sugars and Acidity throughout Width of Singapore Canning Variety at 25—50 per cent Maturity by Skin Colour.

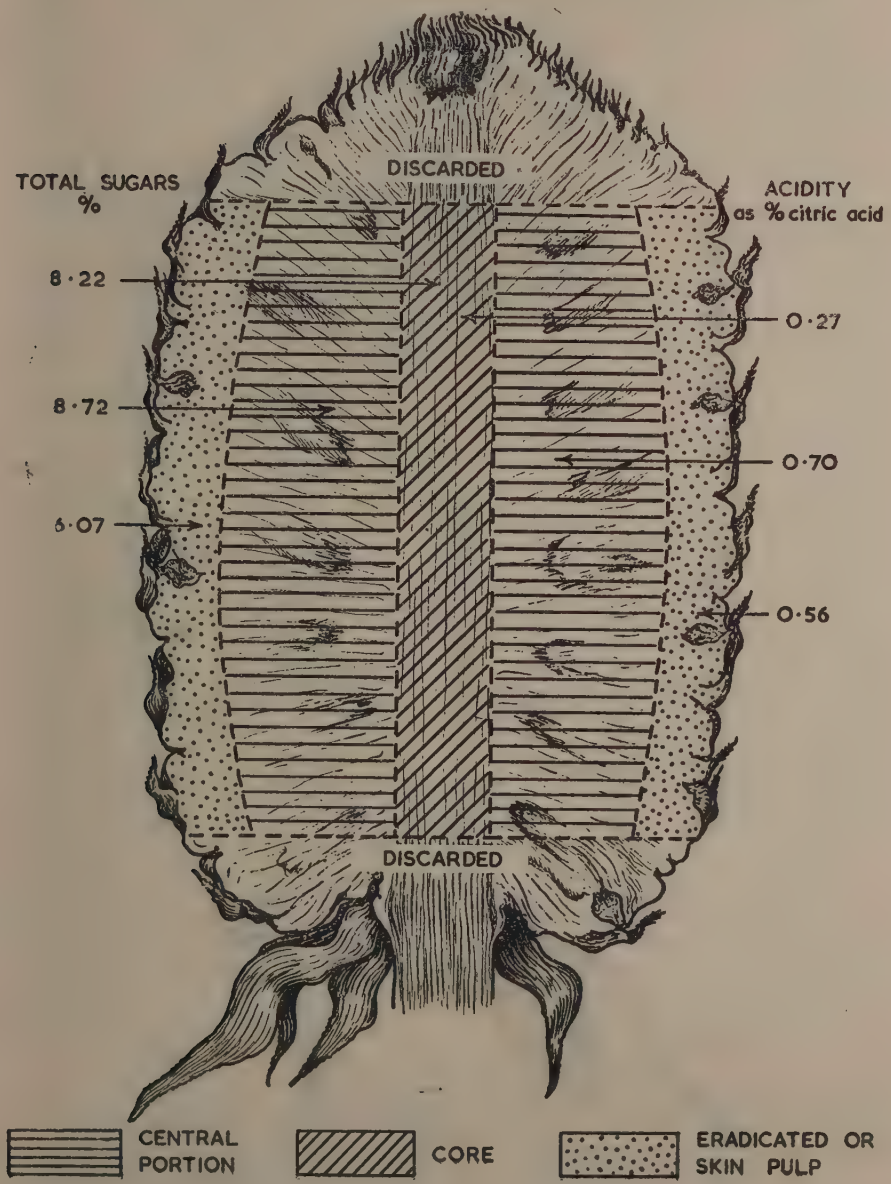
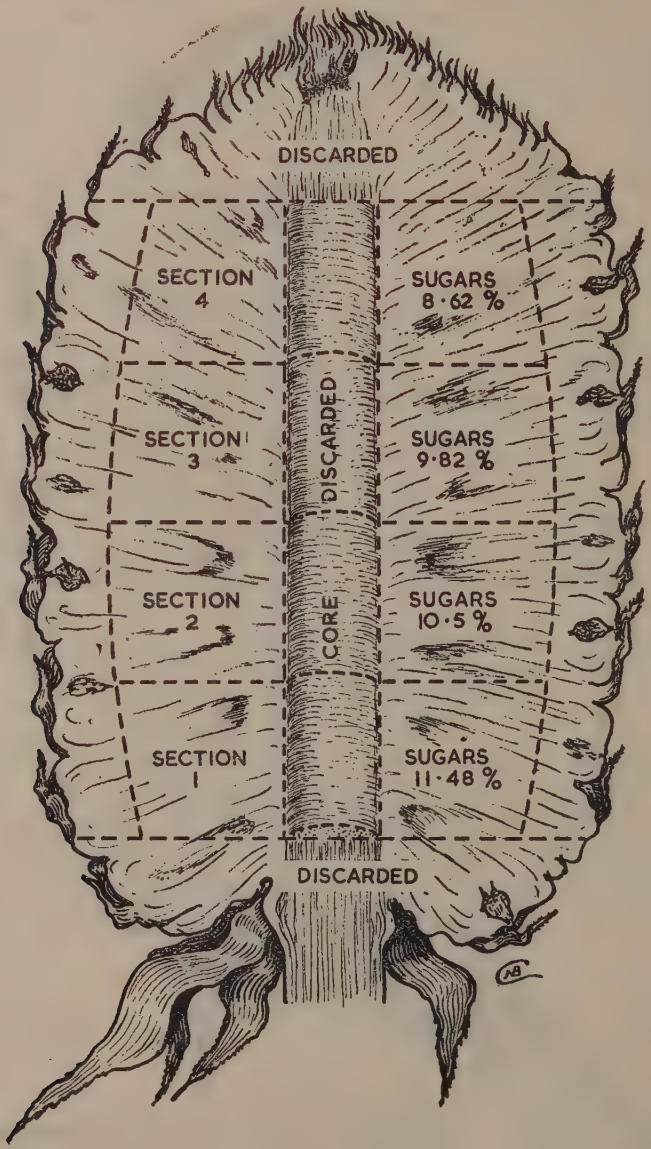


FIGURE II

Section showing Distribution of Sugars throughout Height of Singapore Canning Variety at 75 per cent Maturity by Skin Colour.



after passing through a comminuting machine whereby it is reduced to a uniform degree of fineness. Deeper eradication gives a lower quality material which may be suitable for juice extraction.

The bulk of the material from the skins, together with broken slices and other such pieces, and drainage from the fruit preparation department, is used mainly for juice extraction. All such material is crushed fine then usually preheated to 160° to 190°F and afterwards passed to a juice extractor which is normally of the expeller extractor type. It is important to control the temperature carefully at this stage because heating to a lower range can provide ideal conditions for fermentation and over heating can cause caramelisation. Preheating should inactivate the enzymes, arrest the onset of fermentation and may aid in juice recovery. It is possible, using commercial size equipment, to obtain 60 lb. of good quality juice per 100 lb. of pulp.

In order to produce a good quality juice it is essential to select carefully the raw material and processing must take place as rapidly as possible after the fruit is peeled. Delayed processing gives a poor quality juice, due mainly to the activity of enzymes. A good quality product should have a stable cloud, as has been found in the case of orange juice when the pectins have been protected from enzyme activity (8).

The amount of pulp entering the juice can be controlled by the size of the perforations in the extractor screen which is usually 0.02 inch for many fruit juices. Afterwards the juice may be centrifuged as a further control on the pulp content and to throw out specks of foreign matter. In some factories the juice is homogenised before canning. In some juices, such as tomato, homogenisation does improve the texture and prevents the suspended solids from settling out on standing. This improvement in smoothness does bring about, in some instances, what appears to be an improvement in flavour. Homogenisation does not effectively improve the quality of Malayan pineapple juice and the use of such a machine is not justified.

It is reported by Seale (9) that pineapple contains three distinct types of protein which are associated with juice cloudiness. Two of these are precipitated on heating to 170°F and the final cloudiness, which develops on further heating, is removed by the addition of acetic acid and potassium ferrocyanide. The bulk of the cloudy matter in Malayan juice precipitates on heating to 200°F and full clarification can be obtained by filtering the heated juice through a double layer of Sterimat Filter pads. Such juice is suitable for use as a base for canning syrup. Experiments have shown that the best quality is obtained if the pH of the juice is adjusted to 5.0 before the addition of sugar for syrup preparation.

Pineapple Juice Concentrate

As mentioned earlier, the inner parts of the fruit are higher in quality than the skin material, thus broken slices, etc., from that part of the fruit can improve the quality by increasing the soluble solids in

the juice. Pineapple juice, however, contains over 75 per cent water and it was decided to investigate the possibility of removing some of this moisture and thus reduce the bulk of the juice to a concentrate suitable for shipment. It was realised that production of such a product could effect a saving in cans, cartons, packing and freight charges. Moreover, it would be possible to control the amount of soluble solids on reconstitution and thereby possibly widen the scope for the use of this product.

Experiments were conducted on juice concentration using a Majonnier low temperature evaporator (Plate II). For this work the juice was prepared mostly from whole peeled fruit by the method already described and then pasteurized and filtered to remove suspended solids which can be added back afterwards to the concentrate. The juice was allowed to cool to near room temperature before being fed to the evaporator. The temperature of evaporation is 64°F. It was found possible to evaporate to 70°Brix but at higher concentrations the viscosity was too high to allow pumping of the product through the evaporator tubes. The condensate was practically flavourless and it was considered not worthwhile to attempt the recovery of any flavouring material from it.

Experiments were conducted on dilution of the highly concentrated juice to 45°Brix with straight juice and further dilution to normal strength with water, as is sometimes practised with orange juice concentrate. This method of reconstitution did not bring about any improvement and it was decided therefore that processing and storage experiments should be done with the higher Brix concentrate.

After evaporation, the juice was heated to 190°F, poured into sterile lacquered cans and stored at room temperature. After 24 hours some cans were opened and juice examined. A slight browning of colour and caramelized taste was noted. Further experiments showed that holding the juice at high temperature had a direct effect on development of browning. Juice held for 30 minutes at 212°F gave a very pronounced change in colour and flavour.

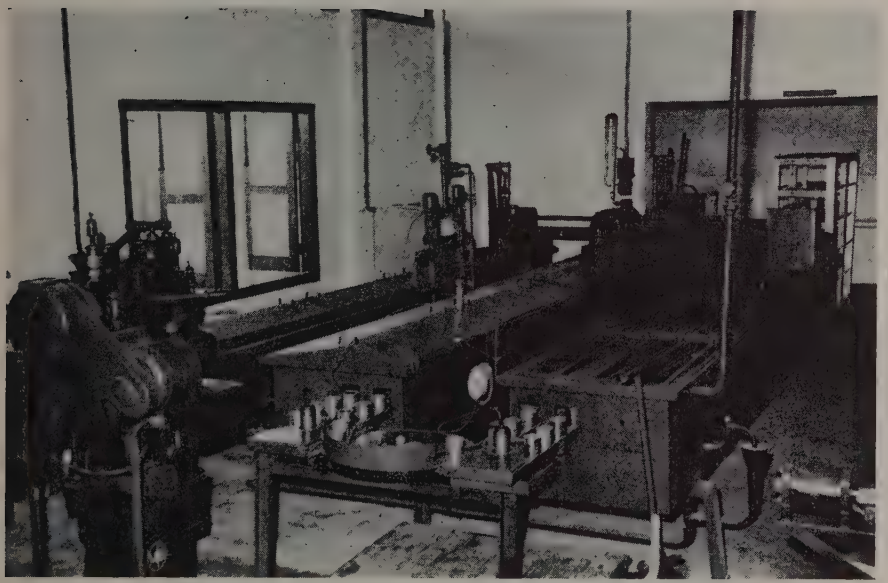
There is sufficient evidence to show that this change in colour and flavour is of the non-enzymatic type and is, in all probability, due to complex chemical reactions within the product itself, and which are more difficult to control. This problem has arisen in other fruit products. Studies on the cause of browning in dried apricot and peach purees have been made by Anet and Reynalds (1). They and other workers have shown this to be due to chemical reactions between amino acids and certain invert sugars in fruit products.

Working with a concentrate of 65 to 70°Brix it was found that freezing at 16°F immediately after evaporation and subsequent storage at 32 to 36°F gave a product that had not changed and had excellent keeping quality. To preserve this product by heat it is essential to flash pasteurize and store preferably at chilled temperatures.

Summary

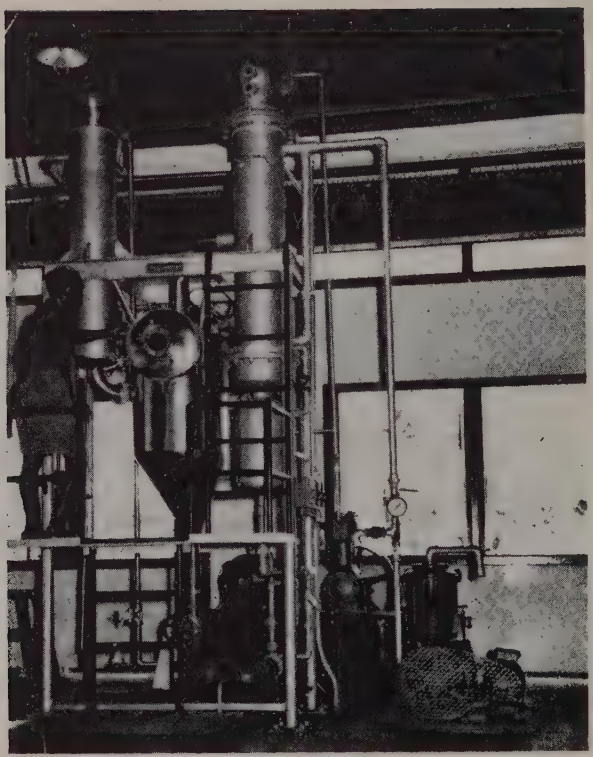
(1) The canning qualities of the four local varieties of pineapple are discussed and also the effects of fruit maturity on quality.

PLATE I



Fruit canning line installed at the Canning Research Station, Johore.

PLATE II



Majonnier low temperature pilot plant evaporator installed at Canning Research Station, Johore.

(2) Experiments on the total recovery of edible matter and its distribution within the fruit are discussed.
(3) It is shown that there is considerable variation in the quality of the edible material in various sections of the same fruit.
(4) A description is given of the preparation of pineapple juice and the more salient factors affecting its quality.
(5) Experiments on the production of pineapple juice concentrate and the problems arising from the development of off-flavour and colour in the final product are discussed.

Acknowledgements

Thanks are due to the Malayan Pineapple Industry for the various items of pilot plant equipment and fruit samples which were made available. Thanks are also due to Mr. Cheah Thean Eng and Mr. Lee Kong Cheong for their work on chemical analysis and to Che Ahmad bin Hamzah who collected and processed the various samples.

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OIL PALM SEEDLING BLIGHT

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Introduction

Until 1952 no serious leaf-spotting disease of oil palm seedlings had been observed in Malaya. Several fungi had occasionally been recorded on seedling leaves but none appeared to be either widespread or vigorously pathogenic. Thompson (3) in 1939 recorded that *Pestalozzia palmarum* (*Pestalotiopsis palmarum* (Cooke) Steyaert) and a species of *Helminthosporium* occurred on seedling leaves but he did not regard these fungi as serious parasites. Other fungi found since then on seedling leaves include species of *Corynespora* and *Leptosphaeria* but these are not common and are of no economic importance.

Specimens of oil palm seedlings heavily affected by leaf spots were observed for the first time in 1952 (4), on an estate in Selangor. The seedlings were badly damaged, the outer leaves and in some cases the whole plant being killed. A fungus, proved by artificial infection tests to be pathogenic, was isolated from affected plants (4) but as the disease did not recur, detailed investigations were not at that time undertaken.

The next known outbreak of this disease did not occur until 1955, when affected seedlings were found on an estate in north Johore. Since then the disease has been found in several other localities in Selangor and Johore and also in Perak. As the disease can cause severe damage in oil palm nurseries investigations were reopened, the object being to discover the identity of the pathogen and to investigate the possibility of applying control measures.

Occurrence and Economic Importance

The disease in sporadic in occurrence and it has not yet been found possible to correlate its appearance with weather conditions. Unlike many similar leaf diseases, its spread does not appear to be dependent on wet weather. A severe attack developed, for instance, in Selangor in July-August, 1958, towards the end of a particularly dry spell of weather, and other occurrences in different localities have also been observed during comparatively dry weather.

The economic effects of the disease are threefold. In the first place, light attack results in some retardation of growth and stunting, so that seedlings are weakened and planting out may have to be delayed. Secondly, there is a direct loss caused by the death of the worst affected seedlings. Rather less severely attacked plants may not be completely killed but often receive such a set-back to growth that they never recover fully and cannot be planted out. Where valuable pedigree seedlings are involved considerable direct monetary loss may be sustained in this way

when infection is severe. Thirdly, perhaps the most serious effect is caused by a sudden unexpected loss of a high proportion of the seedlings in a nursery. This may result in an acute shortage of seedlings and the upsetting of a long term planned planting programme.

Symptoms

The disease is first seen as minute, round, translucent yellow spots, which from their earliest appearance are visible on both surfaces of the leaf. These very soon develop a light brown, slightly depressed centre. As the spots develop, they become darker brown and irregular in shape, but are usually slightly elongated along the leaf axis. Each spot is surrounded by a well-defined, narrow translucent yellow halo. The mature spot has, immediately inside this yellow halo, a narrow raised greenish brown, oily-looking rim. Within this is a reddish brown region showing one or two roughly concentric, irregular, lesser ridges. The centre of the spot is thin and light brown or fawn in colour. Isolated spots when fully developed may be up to 7 to 8 mm. in length. Spots of various ages are illustrated in Plate I.

The youngest unfolding leaf is most susceptible to infection. The disease can also attack the next one or two older leaves, but as the leaves age they become more and more resistant to the disease.

When attack is light and only a relatively small number of spots occur on the leaves, the disease has little effect on the growth of the seedlings. The spots remain discrete and the seedlings are not visibly adversely affected, although the experiment on control of the disease, described below, shows that even light infection may result in some stunting. When infection is heavier and leaf spots are numerous the result is the premature death of the leaves. These dead leaves become dry and curl downwards and being brittle tend to fragment and disintegrate. On the dead leaves the original infected spots remain conspicuous, being darker brown than the rest of the leaf. The outermost leaves die first and the disease progresses inwards until, in the most severe cases, all the leaves are killed and the plant dies. Less severely affected plants may recover but growth is retarded.

The disease may appear on seedlings while still in the seed bed but infection on such young plants is not serious and in most instances only a few leaf spots are formed. Plants are most susceptible to attack in the first few months after transplanting into the nursery and it is at this stage that most damage occurs and most deaths take place. Seedlings attacked at this age are shown in Plates II and III. The disease continues to attack older seedlings but with increasing age resistance also increases. By the time the seedlings are transplanted into the field they are virtually immune from attack.

The Causal Organism

Occurrence of Fungi on the Leaf Spots

On the surface of young spots no fungus can be seen. On older spots, the centres of which have turned grey, fungi can sometimes be

found. although they are not always in evidence. The fungi most commonly occurring on these spots are species of *Curvularia*.

Isolation

It seemed likely that the disease was caused by a fungus and one of the species of *Curvularia* occurring on the lesions appeared to be a probable cause. Cultures were therefore established from pieces of tissue taken from the edge of young necrotic areas. These pieces were surface sterilised with 0.1 per cent aqueous mercuric chloride solution, washed and planted out on corn meal agar and Quaker oat agar, pure cultures being obtained in the usual way by sub-culturing.

It was found that two fungi were consistently isolated. These were identified as species of *Curvularia* and *Gloeosporium*.

Proof of Pathogenicity

To discover whether either of these fungi was the cause of the disease, they were inoculated separately on to the leaves of young oil palm seedlings grown in pots. Inoculations were carried out by placing drops of a suspension of spores, or pieces of culture medium bearing mycelium and spores, on the leaves. The inoculated areas were covered with wet cotton wool and the whole plants were enclosed in polythene bags to maintain high humidity. Check plants were treated similarly except that sterile water or sterile pieces of culture medium were used instead of inoculum.

A series of such experiments was carried out with several isolations of both fungi from different localities. In no case did the check plants or the plants inoculated with *Gloeosporium* show any signs of infection, all remaining healthy until the end of the experiments. Leaf spots developed, however, on most of the plants inoculated with the *Curvularia*. Infections first became visible just over a week after the fungus was applied to the leaves, the first symptom being the appearance of minute translucent yellow spots. Within a few days these spots enlarged and developed a light brown central area and within two weeks larger spots similar to those found in the field had developed.

Cultures were made from surface-sterilised pieces of tissue from the edge of these spots in the same way as in the case of the field infections and the same species of *Curvularia* was recovered. The fungus was thus shown to be the cause of the disease.

Inoculations were carried out using normal sub-cultures and also single spore isolates. Similar results were obtained in both cases.

The species of *Gloeosporium* was not investigated further as it appeared to be a saprophyte quickly invading the tissues attacked by *Curvularia*. Its purely saprophytic role was emphasised by a short series of experiments in which seedlings were inoculated with a mixture of the two fungi. Other plants were at the same inoculated, some wth *Curvularia* along and some with *Gloeosporium* alone. Whether *Curvularia* alone or a mixture of the two fungi was used, the first signs of

PLATE I

Part of the leaf of a plant affected by seedling blight.

PLATE II

Young oil palm seedling showing a moderate attack by seedling blight.

PLATE III

Young oil palm seedling severely affected by seedling blight. Most of the leaves have been killed.

PLATE IV

The fungus of the *Curvularia maculans* group which causes seedling blight.

infection appeared at the same time, leaf spots developed at the same rate and the final spots were indistinguishable. As in previous tests, the *Gloeosporium* alone was unable to attack the leaves.

Identity

The fungus causing seedling leaf blight belongs, as mentioned above, to the genus *Curvularia*, erected by Boedijn (1) to include fungi of the *Dematiaceae* characterised by 4-5 celled conidia, usually bent but sometimes straight, with one or more of the middle cells enlarged and more deeply coloured than the others, and with the end cells sub-hyaline. Conidiophores are unbranched, septate and brown, and conidia are borne on them in whorls or spirally.

The fungus under discussion produces in culture ellipsoid, straight, tri-septate spores. The two middle cells are large, thick-walled and dark, while the terminal cells are smaller, sub-hyaline and thin-walled (Plate IV). The spores are 20-27 μ long and 12.5-14 μ broad, with a mean size of 24 x 12 μ. In culture these spores are produced in dense whorls on long, erect conidiophores, there being not uncommonly up to about 12 whorls on a single conidiophore. Sporulation is profuse on most of the common standard media. It is particularly abundant on Sabouraud's agar but is also plentiful on malt, potato dextrose, prune and Quaker oat agars.

The tri-septate, straight spores, the two middle cells of which are larger and darker than the terminal cells, show that the fungus belongs to the *maculans* group of the genus *Curvularia*. The fungus has not been specifically identified but of the described species in this group it most closely resembles *C. maculans* (Bancroft) Boedijn itself.

Control

When the disease first appeared control was attempted by spraying with copper fungicides, the materials used being copper oxide and oxychloride formulations containing 50 per cent copper. When applied at the concentration normally used on other crops (0.25 per cent) it was found that severe scorching of the foliage was apt to occur, particularly on young seedlings, and it therefore became necessary to reduce the concentration of fungicide. A strength of 0.1 per cent was found to be safe.

The severity of the disease was reduced by applying this lower strength of copper fungicide but it was felt that more effective control might be achieved by using a non-copper type of fungicide which could be used safely at a higher concentration. To investigate this possibility an experiment was laid down with the cooperation of Mr. E. A. Rosenquist, Research Officer, Chemara Research Station (Oil Palm Branch), the experiment being carried out on the Bukit Badak Division of Oil Palms of Malaya, Ltd.

The object of the experiment was to compare the effectiveness of three non-copper fungicides and one copper fungicide and to discover whether any of these materials would successfully control the disease.

The copper fungicide used was a copper oxychloride formulation (Shell Copper Fungicide) applied at a concentration of 0.1 per cent. The other fungicides were used at a concentration of 0.2 per cent. They were Fernide (active ingredient thiram), Orthocide Captan (active ingredient captan) and Dithane Z-78 (active ingredient zineb). Spraying was carried out at weekly intervals. In addition to these four treatments, unsprayed seedlings were also included as a check.

The layout used was a 5 x 5 Latin square, each plot consisting of 25 seedlings. A single guard row of plants was left between plots to reduce spray drift from one plot to another. Spraying was begun when the plants were approximately six months old and continued for four months, when recording of results was carried out.

To assess the effect of the treatments on the incidence of the disease all palms were scored after four months' spraying according to the following arbitrary scale:

1—Severely affected
2—Moderately affected
3—Slightly affected
4—Very slightly affected
5—Free from infection

A mean figure for infection was then obtained for each plot; a summary of the results is shown in Table I under the heading Disease Index.

Table I

The Effect of Fungicides on Disease Incidence and Seedling Growth.

	Disease Index	Frond length (inches)
A. Thiram	3.62	22.1
B. Captan	3.36	23.0
C. Zineb	3.54	22.6
D. Copper oxychloride	3.35	20.5
E. Unsprayed	3.19	19.3
Standard Error	0.116	14.48
Minimum Significant Difference 5%	0.25	3.2
Minimum Significant Difference 1%	0.36	—

Because of the late appearance of the disease spraying was begun later than would have been ideal, the seedlings being six months old at the beginning of the experiment and therefore past the most susceptible stage. As a result of this and also weather conditions, which were not particularly favourable to infection, the level of disease was low, falling in all treatments between the categories slightly and very slightly affected. Despite this, a significant decrease in the incidence of the

disease was produced by spraying with the fungicides containing thiram and zineb, the decrease in the case of thiram being significant at the one per cent level and in the case of zineb at the five per cent level.

Measurements were also taken to discover whether spraying had any effect on the growth of the palms. The length of the longest frond of each palm was measured at the end of the four months' spraying period, the mean for each plot being taken as an indication of growth. The results of these measuremets are summarised in the last column of Table I.

Spraying with captan and zineb resulted in an increase in frond length as compared with the no spray treatment, the differences being significant at the five per cent level.

Discussion

The origin of this disease is not known. The diseases of oil palm have been under investigation since the crop was first planted in Malaya and it is unlikely that such a conspicuous disease would have been overlooked for long. It therefore appears likely that it is of fairly recent origin. The disease has not been described from any other territory and has therefore probably not been introduced on planting material: possibly the causal fungus has occurred previously on oil palm without causing more than very light leaf spotting but has recently become more virulent. Or it may have occurred on other plants (e.g. uncultivated palms) and may only recently have become adapted to the oil palm. Whatever the origin of the disease, it now can be found widely through Malaya, its distribution being aided by the ease with which it can be transferred from place to place on young seedlings. It is likely that heavy attacks will continue to take place.

As is found to be the case with other similar leaf diseases, it appears from the first experiment that at least partial control can be achieved by spraying with fungicides, suitable materials being thiram, zineb and possibly captan. The discovery that even a light attack can apparently result in depression of growth, as shown by the spraying experiment, was unexpected and indicates that even when the disease is causing only slight leaf spotting it may be worth while applying a fungicide.

As in the case of most leaf diseases it is essential for effective control that spraying should begin a soon as the first symptoms of disease are seen. Where an attack has been allowed to build up before spraying is begun, results of spraying are unlikely to be good, but in such a case it would be advantageous to remove and burn the older dead or dying leaves, as the fungus sporulates freely on such leaves. On the other hand, as only the younger leaves are susceptible to attack, particular attention should be paid to ensuring that these young leaves are thoroughly covered with fungicide, spraying of the older leaves being unnecessary.

Working with freckle, a somewhat similar disease caused by *Cercospora elaeidis* Stey., Robertson (2) in Nigeria has shown that the addition of a sticker to the fungicide may result in improved control. Further investigation may demonstrate the advisability of adding a sticker when spraying against seedling blight.

Summary

A new leaf disease of oil palm seedlings, named "seedling blight," is reported and the symptoms described. The cause is shown to be a fungus of the *Curvularia maculans* group.

A first experiment has shown that the disease can be partially controlled by spraying with fungicides, of which thiram and zineb appear most promising.

Acknowledgements

I have pleasure in acknowledging the help given by E. A. Rosenquist, Chemara Research Station (Oil Palm Branch), particularly in carrying out the spraying experiment.

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SOME MARKING EXPERIMENTS WITH THE TILAPIA FISH

BY

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Introduction

Tilapia mossambica Peters, though a fish native to the eastward-flowing rivers of East Africa, from Somaliland to Natal, has become acclimatised in Malaya, and indeed is widespread throughout south-east Asia. It appeared, in a way which has never been explained, in Java, in July 1939 (1) where five specimens were found. It spread with great rapidity throughout Java, and was transplanted to Malaya by the Japanese.

It is approprite that the Fish Culture Research Station should give much attention to this fish; for, as a Commonwealth Station, research on this fish would be of immediate interest, not only to Malaya and other south-east Asian territories, but to East Africa, and also to the West Indies, for the fish has become acclimatised there also.

Marking is a widely-used technique in fishery biology. It enables individual fish to be identified, as if they carried identity discs, and is the only certain way of finding out how fast fish grow, how they migrate, and, in special cases, their mortality rate. In this paper, only the growth-rate is considered.

Obviously, if a fish carries a numbered label, and is measured and weighed carefully before being put in a pond and then, at later periods, is recaptured, identified, re-weighed and re-measured; then the difference in length and weight between successive recaptures is the growth of the fish, in a way not open to dispute. In tropical conditions, where there may be no seasonal changes to affect the scales and other bony structures, marking is the only reliable method of determining the rate of growth.

However, in addition to attaching numbered labels to fish, fish may be identified by fin-cutting. One or more of the fins may be cut in such a way that the fish can be recognised again. As the possible number of variations of cut-fins is small, this method is more useful for distinguishing groups of fish rather than individual fish.

A trial was made of this method, to find out whether fish marked by fin-cutting were handicapped in their growth as compared with whole fish, and to find whether the marked fish could be readily recognised again.

Fin-Cutting Experiments

On April 3rd, 1958, a sample of 88 small female and 102 small male Tilapias, of a length between 6 and 10 cm., were each divided into four groups, of which one group consisted of entire fish (controls), and of which the remaining three had respectively one pelvic fin, both

pelvic fins, and the dorsal fin cut off near the base. Males and females were reared in separate ponds; they were not fed, but the food naturally produced in the ponds was stimulated by the addition of a mixture of artificial fertilisers, usually basic slag and muriate of potash.

The experiment ran for six weeks, and was ended on May 21st, 1958, when the ponds were emptied and the surviving fish picked up and examined. The results are given in Table I below:—

Table I

Results of a Fin-Cutting Experiment with Malayan Tilapias.

	Whole Fish	1 Pelvic Fin Cut	2 Pelvic Fins Cut	Dorsal Fin Cut
Male Fish Pond H6				
Number marked	27	25	25	25
Average Length	6.9 cm.	6.7 cm.	7.0 cm.	7.2 cm.
Number recaptured	38	3	1	10
Average Length	11.8 cm.	12.0 cm.	13.0 cm.	12.3 cm.
Average Weight	34.2 gm.	39.7 gm.	50 gm.	40.0 gm.
Percentage recaptured All fish	53	12	4	40
Female Fish Pond H3				
Number marked	22	22	22	22
Average Length	6.7 cm.	6.8 cm.	6.6 cm.	6.6 cm.
Number recaptured	43	1	—	7
Average Length	12.7 cm.	14 cm.	—	12.9 cm.
Average Weight	41.2 gm.	52 gm.	—	41.6 gm.
Percentage recaptured All fish	58	5	0	32

The first result shown by the table is that apparently far more whole fish were recovered at the end of the experiment than at the start, in spite of an overall mortality of some 46 per cent in males and 42 per cent in females. As, apparently, at the same time very few of those fish with cut pelvic fins survived, it is obvious that the pelvic fins regenerate rapidly, so as to be, in most cases, unrecognisable as having been cut. The fish bearing these were therefore counted with the whole fish.

Fish with the dorsal fin cut were more easily recognisable. The percentage of fish with the dorsal fin cut which were recovered at the end of the experiment, at 40 per cent for males and 32 per cent for females, when compared with an overall mortality of 46 and 42 per cent respectively suggests that most of the fish with a cut dorsal fin which were missing at the end of the experiment had died, rather than that the dorsal fin had regenerated.

Comparing the growth of the "whole" fish (including those with regenerated pelvic fins) with that of the "cut" fish, combining, for convenience, the few recognisable fish with cut pelvic fins with those with cut dorsal fins, Table I shows that the male "whole" fish grew on an average by 4.8 cm. in length and to an average weight of 34.2 gm., as compared with 5.0 cm. in "cut" fish and an average weight of 40.0 gm. The "cut" fish therefore, far from being handicapped, appear to have grown rather better than the "whole" fish.

Applying the test of the Significance of the Difference of Means, we find, in the case of the males:—

Mean weight, whole fish 34.2 gm. $n = 38$

„ „ cut fish 40.0 gm. $n = 14$ $s = 6.36$ $t = 2.934$

As the value of "t" at the 0.01 level is 2.576, (Fisher 2)., the difference between the two means is very significant. There is less than one chance in a hundred that the two sets of growth data are drawn at random from the same field.

In the case of the female fish:—

Mean weight, whole fish 41.2 gm. $n = 43$

„ „ cut fish 42.9 gm. $n = 8$ $s = 9.00$ $t = 0.5076$

As great a difference as this would be obtained by chance seven cases out of ten in random material; so the slightly greater mean weight of the "cut" female fish has no significance.

It is difficult to explain why the "cut" male fish have apparently grown significantly faster than the "whole" fish. The obvious explanation is, that the smaller "cut" fish have survived less than the larger "cut" fish, thus giving an apparently large mean growth in the survivors. But the female fish do not show this feature.

At all events, the data do not suggest that fin-cutting handicaps the growth of the fish.

Table I shows that the fish grew considerably during the six weeks of the experiment. Though they were not weighed at the time of marking, it is known, from thousands of other observations, that fish of 6-7 cm., have a weight of about 6 grams. In the six weeks, therefore, male fish grew by 5 cm., in length and 30-40 gm. in weight. The female fish grew by about 6 cm., in length and 35 gm., in weight.

Four of the fish with cut dorsal fins were readily recognised many weeks later, when the pond to which they had been transplanted at the close of the above experiment was finished. Their measurements were as follows:—

Date	*Sex*	*Length*	*Weight*
13.6.58	♂	19.0 cm.	—
- do -	♂	19.2 cm.	—
24.7.58	♀	17.4 cm.	85 gm.
- do -	♀	19.2 cm.	104 gm.

Thus, in 74 days the males had grown from 7 to 19 cm., while in 115 days the females had grown from 7 to 17 and 19 cm., respectively, and from about 7 gm., to 85 and 104 gm., respectively.

The Growth Rate of Tilapias

In the rest of the experiments described here, the fish were marked by yellow plastic labels, each bearing a number, which were attached to the back of the fish just below the hinder part of the dorsal fin by surgical stainless steel wire passed through the muscles with a surgical needle. The marked fish were kept under observation for several days in the aquarium tanks before release in the ponds; there was no mortality due to the marking.

The Growth of Tilapia Mossambica Peters.

Many of the marked fish lost their marks, and we are concerned here only with those fish recaptured with the marks still in position. Usually, the fish, after recognition, measuring and weighing, were again released; and some were caught two or even three times. In these cases, the actual growth of the fish is shown.

Full details of recaptures are given in Table II.

Table II

Results of some Marking Experiments with Malayan Tilapia Mossambica.

Label Number	Sex	Length at Marking (cm.)	Date of Marking	Length and Weight at recapture, with dates.		
					cm. gm.	cm. gm.
528	♀	10.6	21.2.58	11.5 cm.	20.1 140	22.4 190
				3.4.58	24.7.58	4.9.58
535	♀	8.4	21.2.58	21.7 cm.	23.1 210	—
				20.5.58	25.7.58	—
				cm. gm.		
548	♀	9.7	12.3.58	21.4 160	22.4 190	23.3 210
				24.7.58	4.9.58	23.9.58
526	♀	11.2	12.3.58	20.6 cm.	21.7 185	21.8 172
				13.6.58	4.7.58	16.7.58
649	♂	7.5	21.2.58	20.6 cm.	23.0 210	
				13.6.58	16.4.59	—
527	♂	13.8	7.2.58	19.6 cm.		
				11.4.58	—	—
614	♂	15.0	7.2.58	20.2 cm.		
				28.3.58	—	—
544	♀	11.1	12.3.58	14.7 cm.	20.8	21.5 170
				26.3.58	20.5.58	24.7.58
					25.7 310	26.1 305
					16.1.59	20.4.59
				cm. gm.		
547	♀	10.8	12.3.58	21.3 150	21.5 160	
				24.7.58	4.9.58	—
642	♀	10.0	7.2.58	24.5 250	25.3 270	24.4 215
				24.7.58	4.9.58	17.1.59
						25.0 265
						16.4.59
617	♂	14.5	7.2.58	19.5 cm.		
				27.3.58	—	—
524	♂	12.5	21.2.58	14.9 cm.		
				3.4.58	—	—

From these data, certain fish are selected to give Figures 1 and 2. Few males are available, for the marked males were planted out in the

one-acre rearing ponds for six months, and none were recaptured with the marks in position. The marked females, however, which were reserved for breeding, were kept in ¼ acre stock ponds throughout.

Males and females were reared in separate ponds, so the data show growth unchecked by the stress and starvation of breeding. However, one fish, number 526, was used for breeding as from 4.7.58. It will be seen that, when she died 12 days later in a breeding tank, she had lost 13 gm., in weight.

The data show that, in the circumstances of this experiment, female *Tilapia mossambica* can reach a length of 23-25 cm., and a weight of 200-250 gm., in 200 days. No food was given these fish; but the ponds were fertilised at intervals with a mixture of muriate of potash and phosphate of ammonia. It must also be stressed that the ponds were not over-populated. Each carried a stock of about 50 fish, or 200 per acre. A slower rate of growth would undoubtedly have been shown, had the natural food available in the pond been shared among more fish.

FIG 1

Increase in Length by Three Marked Female Fish. Data from Table II.

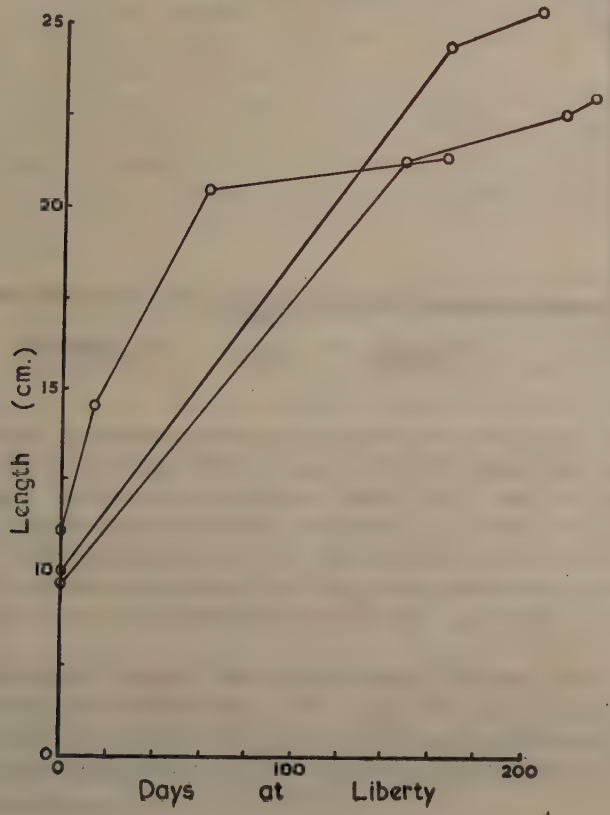
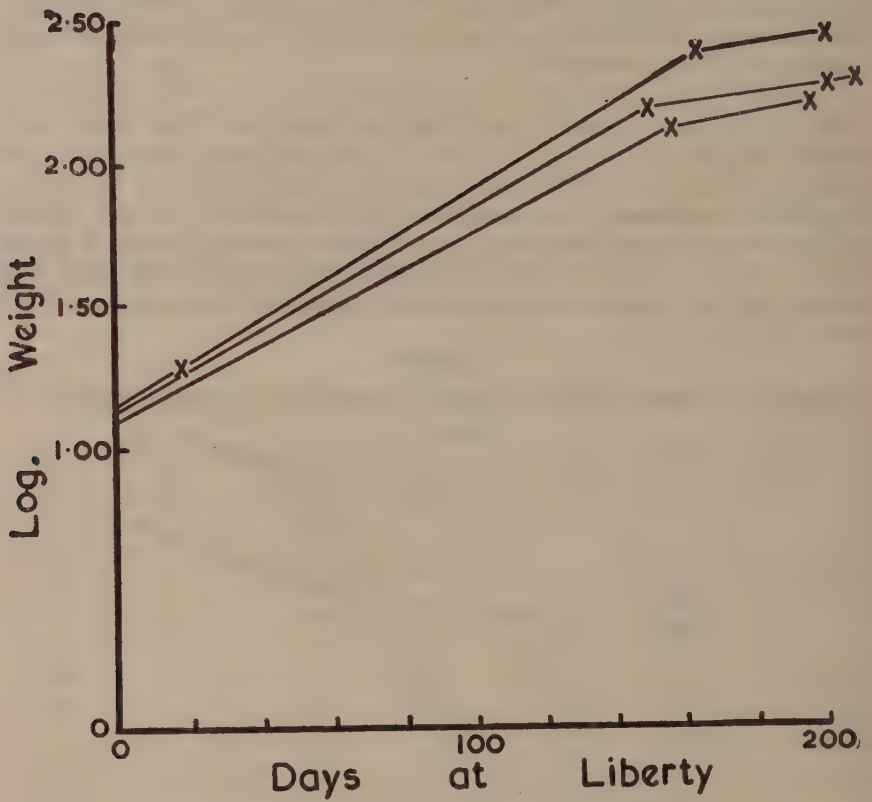


FIG. 2

Log. Increase in Weight by Three Marked Female Fish.
Data from Table II.



There seems to be a check to the rate of growth in length at about 22 cm., and some indication of a check in the rate of growth in weight after about 200 gm. This check is best seen when the logarithms of the weights are plotted, as in Figure 2. Possibly these checks are natural, and not due to the environment; for in nature, females of *Tilapia mossambica* greater than 20 cm., in length are rare. Indeed, the largest female I have seen was only 31 cm., taken from the Ferry River in Jamaica.

The three marked males showed fast growth, from 14-15 cm., to 19-20 cm., in only 46 to 49 days. It is well known that, in this species, the males grow faster than the females; but the data in Table II do not prove this, for the males were reared in a different pond from the females.

A Comparison of the Growth-Rate of Malayan and African Tilapias.

For cross-breeding purposes, Tilapias were imported by air from East Africa. The imported fish were not, apparently, *T. mossambica*, but a closely allied species in the *T. mossambica* group. The breeding dress of the males in the two species is quite different, and there are other differences; for example, the position of the oviduct on the genital papilla differs between the two species; and the pattern of stripes on the flanks tends to be vertical in *T. mossambica*, but horizontal in the African species. These differences are notable enough, at all events, to allow the two species to be picked out by eye with reasonable certainty.

Preliminary to the cross-breeding work, a marking experiment was done to find out which of the two species had the better rate of growth. To avoid growth complications due to breeding, the experiment was done in two 1/10th acre ponds, with marked males in one pond and marked females in the other.

The experiment was began on June 19th, 1958, and ended on August 2nd, 1958, a period of 44 days. The results are given in Table III.

In the male fish marked, 51 out of 59 survived to the end of the experiment, but of the 51 survivors, only 21 still carried their marks, 15 Malayan males and 6 African males.

Starting at about the same average length, the Malayan males grew faster than the African males. But, in fishpond experiments, the weight is more important than the length, and Table III shows that the Malayan males increased their weight by 60.3 gm., at the same time, and with access to the same food supply, as gave the African males an increased weight of 39. 8gm.

These means can be tested by the Significance of the Difference of Means. In Table III, it will be seen that there was no significant difference in weight between the two lots of males at the time of marking, but that the difference was significant at the time of recapture. Malayan males grew in weight one-third again as fast as African males.

But the reverse was true among the female fish. Again, while there was no significant difference between the mean weights of African and Malayan females at marking. Table III shows that there was a significant diffence at the time of recapture. The African female grew more than twice as fast as the Malayan female. This may perhaps be linked under the observation that Malayan females tend to mature at a smaller size than African females.

A Comparison Between the Growth Rates of Malay and Crossbred Male Tilapias.

The rate of growth of marked male African, Malayan and cross-bred Tilapias was next compared. This experiment ran for 66 days, and the results are given in Table IV.

Table III

Marking Experiment Comparing the Growth Rate of Malayan Tilapia Mossambica with an African Tilapia Species.

	Number of Fish			Average at marking			Average at Recapture		Average Increase		
	Marked	Surviving	Surviving with marks	Lt. cm.	Wt. gm.		Lt. cm.	Wt. gm.	Lt. cm.	Wt. gm.	
Pond H24						**Male Fish**					
Malayan	35	—	15	8.6	12.5	s = 4.96 t = 1.105 P = 0.3 - 0.2	15.9	72.8	7.3	60.3	s = 11.87 t = 2.90 P = 0.01
African	24	—	6	9.1	15.2		15.3	55.0	6.2	39.8	
Total:	59	51	21								
Pond H29						**Female Fish**					
Malayan	20	—	14	9.3	14.8	s = 4.63 t = 1.63 P = 0.2 - 0.1	13.6	41.4	4.3	26.6	s = 10.87 t = 6.11 P = 0.01
African	19	—	6	9.5	16.6		15.7	73.8	6.2	57.2	
Total:	39	37	20								

Table IV

Marking Experiment Comparing Growth Rate of Male African, Malayan and Crossbred Tilapias.

Pond H14

Fish	Number of Fish			Average at marking			Average at Recapture		Average Increase		
	Marked	Surviving	Surviving with marks	Lt. cm.	Wt. gm.		Lt. cm.	Wt. gm.	Lt. cm.	Wt. cum.	
African	4/4	—	2	15.8	56.5	s = 8.18 t = 2.63 P = 0.02-0.01	17.8	85.0	2.0	28.5	s = 22.94 t = 5.89 P = 0.01
Malayan	11	—	7	15.7	65.9		19.4	116.0	3.7	50.1	
Grossbreds	20	—	13	14.4	53.0		22.2	179.3	7.8	126.3	
Total:	35/35	31	22								

Only four African fish were marked, of which only two were recovered, so they will not be considered except to point out that this experiment confirmed their slower growth as compared with Malayan fish. In fact, the weight increase of the Malayan males was nearly twice that of the African males over the period of the experiment.

Table IV shows that there was a significant difference between the mean weights of Malayan and crossbred males at the time of marking. The crossbred fish started with a weight handicap of 13 gm.

Yet the crossbred males grew so fast that 66 days later they had not only made good the difference, but had grown more than twice as fast as the Malayan males, all fish having access to the same food. The final mean weights were very significantly different, as Table IV shows; the crossbred males grew more than twice as fast as the Malayan males, which themselves grew twice as fast as the African males.

These results suggest that the crossbred Tilapias are improved fish as compared with the present Malayan stock.

Summary

The results of marking Tilapia fish by fin-cutting and by attaching numbered discs are described.

As far as the fin-cutting method is concerned, the dorsal fin regenerates less rapidly than the pelvic fins, and is therefore the best fin to mark. The marked fish appeared not to be handicapped in their growth rate as compared with unmarked controls or fish with regenerated fins.

Marking experiments with numbered discs showed:—

(a) that female *Tilapia mossambica* may reach a length of 23-25 cm., and a weight of 200-250 gm., in a period of 200 days, without supplementary feeding;

(b) that Malayan *Tilapia mossambica* males grow faster than imported Tilapia males from East Africa, though the reverse is the case with the females;

(c) but that the cross between African male and Malayan female fish grew more than twice as fast as either parent stock.

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Contrast in size between pure bred African, pure bred Malay and first cross hybrid male Tilapias, of the same age.

MASTER FARMERS OF MALAYA, IX.
CHE SUIB BIN MOHAMAD ALI

BY

ALI AHMAD BIN SULAIMAN

(Cadet Agricultural Assistant)

Introduction

A young man of twenty five, Che Suib bin Md. Ali is a padi planter in Yen District, Central Kedah. He has already shed the cloak of superstition on matters relating to padi planting, and though his father and mother live in the same kampong, Sungai Udang, this young man has a different outlook on life from his more conservative parents. Working on his own initiative and utilizing information and advice from the Agricultural Department, he has greatly increased net annual return from his five *relongs* * of *bendang* (padi land) than he would otherwise have done by following the old methods of padi planting. Che Suib's object is to obtain the maximum return from his *bendang* and to achieve that end he consulted the Agricultural Assistant in his district. For nearly three years now he has been following the advice of the Department of Agriculture, and has achieved progressively higher yields in each season, using a recommended medium term variety. He now sets a good example to neighbouring planters, and is encouraging them by example to improve their techniques.

Improvement of Padi Yield

Seeing is believing: Che Suib never fails to try anything he thinks will be of value in his padi planting. For the past two years the following operations have become a 'must' to this young man in his routine padi planting:—

1. He plants a special *petak* (plot) for his future seed supply. This plot is big enough to give sufficient seed for the following season and yet small enough to allow careful roguing at the time when the padi is flowering. By doing this he is sure of obtaining unmixed seed and planting this pure seed eases harvesting, as the padi ripens evenly.
2. Che Suib harvests his seed padi with a *tuai* (small knife) and stores the grain still unthreshed. The *gemai* (seed heads) are tied in bags and stored in a cool dry place in his *jelapang* (padi store).
3. After winnowing and prior to soaking his seed, Che Suib always uses the salt water solution method of eliminating half filled grains, as he appreciates that only well filled grains will develop into strong healthy seedlings.

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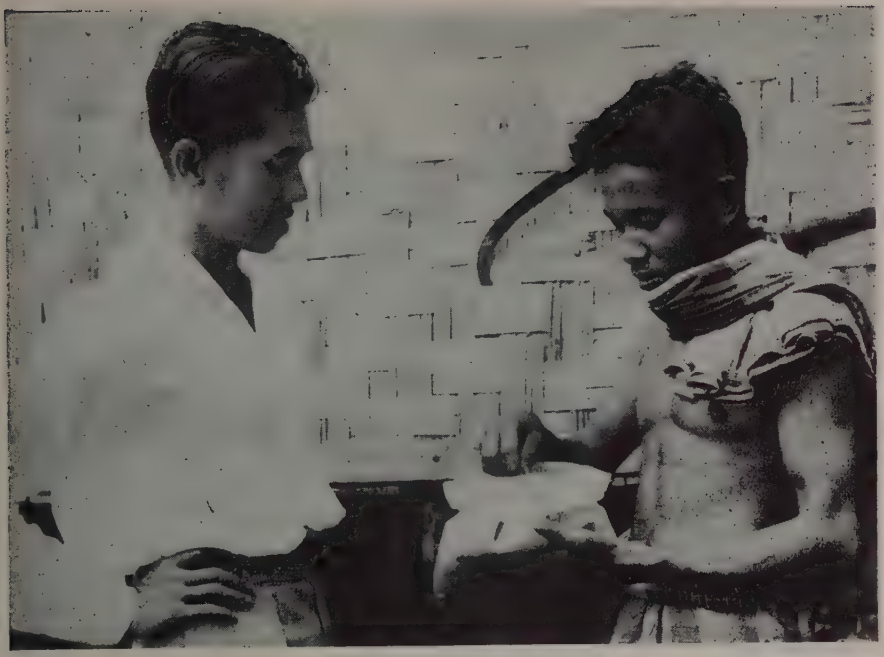
* Kedah *relong* = 0.71 acre.

4. He always make a big nursery area; about 540 square feet for every *gantang* of soaked seed and plants at a seed rate of two *gantang*, per Kedah *relong* (0.71 acre). This season he used ammonium phosphate 11 : 48 at the rate of 2 lb. for every *gantang* (gallon) of seed.
5. He transplants his seedlings between 35-40 days old. By experience Che Suib has found that by using a bigger nursery area, with ammonium phosphate 11 : 48 as the nursery fertiliser, his seedlings are healthy and robust and ready for transplanting in half the time of those of his non-progressive neighbours. His early transplanted seedlings, on an average, give three or four tillers more per hill than those produced by later transplanted seedlings. According to his calculation, based on his standard planting distance of one foot by one foot, his seedlings produce roughly 90,000 to 120,000 tillers more per *relong* than those produced by 'overaged seedlings'. In terms of *gantangs* the increase is roughly 180 to 240 *gantangs* of clean padi per *relong*.
6. He always transplants closely and evenly, using a planting distance of one foot by one foot. His seedlings are big and tall and two or three plants per hill at transplanting are sufficient. This is half the number of seedlings he would have used in planting if his seedlings had been short, stunted and overaged from an overcrowded nursery
7. Christmas Island rock phosphate is the manure Che Suib uses in the field, at a rate of about 75 katies per *relong*. He considers this fertiliser plays a major part in increasing his yield per acre.
8. He is always on the look out for pest damage. If there is an outbreak of Nymphula or army worms in his nursery or padi field he uses Dieldrex 15 solution and a sprayer borrowed from the Agricultural Department. For field rats, he uses zinc phosphide mixed with a wide variety of baits, ranging from boiled padi mixed with bran, *ikan bilis* (small fish) or roasted grasshoppers, to fresh water crabs.

According to Che Suib, his strict adherence to these eight 'rules' enable him to get 30 per cent more income than farmers who follow the old methods of padi cultivation. All cultural operations, ploughing, planting, weeding and harvesting, are done by himself and his family. To substantiate his claim Che Suib gave me the following figures:—

Average yield by old methods	1,600 gts.	=	$ 850
Yield 1956/57 season	1,840 gts.	=	$ 977
Yield 1957/58 season	2,485 gts.	=	$ 1,317

The increase in yield has resulted from the expenditure of only $34 for Christmas Island rock phosphate and ammonium phosphate. All the other improvements did not cost money, they only required more



Che Suib and an Agricultural Assistant examining a sample of urea.

Pest Control in the Nursery. Note bag of ammonium phosphate 11 : 48 on top of post.

Che Suib with the Tunku Abdul Halim Cup, at the State Padi Competition, 1958.

careful attention. From the $34 spent on fertilizer, plus the added care, Che Suib has reaped an increase in return valued at over ten times his initial outlay and is now producing nearly 50 per cent more padi than two years ago. This year he is using urea, 30 *katis* (one *kati* = 1 1/3 lb.) to a *relong,* to boost his padi yield still further.

For the last two years Che Suib has won prizes in padi competitions; a second prize at the M.A.H.A. padi show in 1957 and a first prize in the Kedah State Padi Competition in 1958. This is added proof of his skill and has gained him a wide reputation as a successful planter.

Additional Income

This enterprising young man does not fold his arms or gossip in the coffee shops when the padi season is over. He takes up coastal fishing to increase his income till next padi season. When the catch is good he gets as much as $10 per day. At home his wife helps him look after a flock of forty ducks and fifty hens which are fed on *padi hampas berat* (good quality padi bran) from his *bendang*. The ducks are let loose in his padi fields to pick up insects, some of which would damage his padi plants. An income of $20 a month from the sale of poultry and duck eggs is not uncommon.

Discussion

Che Suib regards his district Agricultural Assistant and Junior Agricultural Assistant as his friends, and co-operates readily in demonstrating new or improved methods on his *bendang*. Thus he benefits not only himself but also his neighbours. He has become the local 'Agricultural Adviser' in his *kampong* (village). Though still young his words are respected by his friends young and old. Che Suib, his wife and his one year old son, are heading for a bright future in this Merdeka age.

NOTES ON CURRENT INVESTIGATIONS AND EXTENSION WORK

January to March, 1959.

Weather

The weather was particularly dry towards the end of the wet padi growing season, but where water supply was adequate the overall yield of padi was good.

Padi

Research

Variety experiments have been harvested in most areas except Selangor and Negri Sembilan. No serious failures were reported but drought has affected the Padi Experiment Station, Pulau Gadong, quite considerably, resulting in many empty grains and yields lower than last year. The Cuttack hybrids at Pulau Gadong suffered from drought and casualties in most ear rows were about 50 per cent. The local hybrids were only slightly affected.

Trials of four Subang Intan selections with Radin Ebos 64 (a post-war selection) and Radin Che Ali, have completed three years at Sala Kanan Padi Test Station, Kedah. Over the years the best of the S. Intans (S. Intan 38) gave five per cent more yield than R.E. 65. Although variety variance over error variance was significant, variety variance over variety x year interaction was not. Because of this, therefore, this five per cent increase cannot be regarded as significant. Another feature of the S. Intans is the difficulty in threshing them.

A trial with five Sarawak varieties and Mayang Ebos 80 as a control has also completed three years at Sala Kanan. Over the years there has been no significant differences in yield between varieties, though Mayang Ebos 80 gave the highest average yield over three years. Mayang Ebos 80 has given consistently good yields in each year and should still be preferred for this area. Indai Empati was the best Sarawak variety at this Station.

A trial to test varietal yield differences of three selected varieties, Siam 29, Siam 76 and Radin Ebos 64, one local variety, Mayang Sesat and one Sarawak variety, Engkatek, has completed two years at Hutan Kampong, Kedah. In the 1957/58 season R.E. 64 significantly outyielded the others, but in the second year Engkatek significantly outyielded the others. Radin Ebos 64 continues to give good yields in this area.

The survey of damage by stem-borers at flowering has now been completed. The 1958/59 padi crop in all main padi areas in all States, except Pahang, was surveyed. Results of the survey show that damage from stem-borers occurred in all the States surveyed. The mean percentage of bored tillers varied from 1.4 for Kelantan to 14.2 for North Perak (Krian). Infestation was generally serious in Krian where, in several cases, the percentage of bored tillers exceeded fifty.

A pot experiment on the insecticidal control of stem-borers was also completed during the quarter. Of the six insecticides used, all except malathion brought about significant increases in yield over the control. The insecticides used were as follows (in decreasing order of effectiveness) :—

Endrex 20, Dieldrex 15, Rogor 40, Gammalin, Diazinon, D.D.T. 25, Malathion 57.

In conjunction with the padi stem-borer insecticidal control experiments, several laboratory tests were carried out during the quarter to determine the relative toxicity of insecticides to padi field fish. Results were inconsistent as there was a high percentage of mortality even in the control tank.

In a tank experiment on poor soil from Batu Kikir, Negri Sembilan, the addition of nitrogen in accordance with standard practic in Negri Sembilan, produced no increase in yield of padi over the control. The addition of nitrogen (100 lb. per acre as N) at weekly or fortnightly intervals gave greatly increased yields. The highest yield recorded in this experiment was 790 gm of dried grain per tank, equivalent to 1,200 *gantangs* per acre; this was obtained with fortnightly additions of nitrogen.

Agronomic Investigations and Extension

Harvesting of wet padi in various manurial and cultural trials was completed during the quarter. At Lundang, Kelantan, agronomic trials were adversely affected by shortage of water.

Examination of results of extension trials in Kedah have indicated that added nitrogen has a beneficial effect on yield. Response to phosphate is not clear, however, due probably to the residual effect of bat guano applied by farmers in previous years. There is evidence from these trials to support the view that response to fertiliser will be limited while husbandry techniques remain as variable as they are at present.

Results from a number of manurial trials support the view that the treatment of padi seedlings in the nursery has an important effect on the yield potential of the crop. The need to clarify this issue and to concentrate on investigation of husbandry practices both in the nursery and the field, has been built into the 1959/60 padi programme, the planning of which is almost complete.

A crop averaging 317 *gantangs* per acre was harvested at the Padi Mechanisation Scheme, Parit. The variety Engkatek reputed to be stiff strawed, developed rank growth on the station but lodging was not serious. Stem borer damage was quite serious. Preparations were made for trial sowings of off-season crops, which are to be managed using machinery. Soya bean, hybrid maize and green gram are the more important crops to be planted.

Padi planting was completed in all States by the end of January. The total acreage planted fell short of the estimate by about 5,500 acres, the actual planted acreage being 869,943 of wet padi with 35,601 acres

of lowland dry padi, and 23,059 acres of upland dry padi. Planting was very late in Negri Sembilan with 1,130 acres planted in January. Inevitably, the yield from this acreage will be very much reduced.

Harvesting of wet padi commenced in December, 1958, and by the end of February, 1959, was in full swing. In Perlis, harvesting was completed by the end of February, in Kedah and Province Wellesley was largely completed, and elsewhere was about 50 per cent complete at the same time, with the exception of Negri Sembilan and Selangor. It is apparent from preliminary figures that the average yield per acre of wet padi will be slightly lower in the 1958/59 season than it was for the 1957/58 season. The reduction is attributable to the prolonged drought which occurred in most States during the latter part of 1958.

Rubber

Distribution of rubber planting material to smallholders, for both new and replanting, amounted to 52,864 yd. of budwood (excluding Pahang) and 800,000 clonal seedling stumps. The very dry weather experienced generally over the country restricted rubber planting, and at the end of the quarter considerable surpluses of both clonal seedling stumps and budwood had built up. It is anticipated that the demand for planting material of both types will increase in the second quarter of the year.

Progress in new planting schemes under assisted rubber planting schemes gathered momentum during the quarter, and all States, except Johore, now have such schemes under way.

Coconut

A plant pathologist visited the coconut growing areas of Johore to find out if anything resembling the "Kadang Kadang" disease of the Philippines is present in Malaya. Leaf specimens were examined from coconut holdings around Muar, Batu Pahat and Pontian, Johore, but no symptoms corresponding to those of "Kadang Kadang" were observed.

The Entomologist visited Telok Bharu Federal Experiment Station, Perak, and the Coconut Rehabilitation Station, Sungei Sudah, Johore, to investigate the level of infestation of *Oryctes rhinoceros*. Young palms at both stations were found to be attacked.

A repeat experiment was carried out on an estate in Selangor with the object of controlling *Oryctes* by means of insecticide-treated trap breeding pits. Of the three concentrations of BHC (0.5%, 0.1% and 0.01% gamma BHC) and 0.5% oleolindrine used in this experiment, it was found that 0.5% gamma BHC gave the best result (63 per cent kill) but this was not considered good enough to check *Oryctes* population in the field.

A laboratory experiment to discover the most effective insecticide for controlling *Oryctes* grubs was set up and half the full-grown grubs

bred in sawdust were used in the test. The insecticides used and the results obtained were as follows:—

		Per cent a.i	Per cent kill in 9 days
(i)	Malathion	0.5	58.3 & 83.3
(ii)	Basudin	0.5	91.7 & 100
(iii)	Endrex	0.5	91.7 & 100
(iv)	Oleolindrine	0.5	91.7 & 100
(v)	BHC w.p.	0.5	— 100
(vi)	Control	—	— 8.3

The results are very encouraging as is often the case with laboratory tests but it should be noted that in the field test on an estate in Selangor, oleolindrine gave only a 3.5 per cent kill and BHC 0.5 a.i. a 63.1 per cent kill.

Nuts from selected palms from both Port Swettenham station and various estates have been planted in nurseries at the Federal Experiment Station, Telok Bharu. The manurial programme for young palms has been revised and response to applications during the quarter has been apparent. *Oryctes Rhinoceros* beetles continue to cause damage on the station, the breeding grounds of the pest being outside the station boundary. Work has started on clearing a further 35 acres of jungle reserve for future planting.

Proposals for a manurial observation on young palms on an estate in the Dindings have been drawn up. Departmental staff will assist in supervision.

The rise in the price of copra, which occurred during the last two quarters of 1958, was continued in the first quarter of 1958. At the end of March, the price was $42.50 per *picul*, compared with $39 at the end of December, 1958, and $34 at the end of September. Smallholder supplies, however, continue to contract, and it is evident that this long term trend is unlikely to be reversed in the near future.

In the west costal coconut areas of Johore the increase in the amount of damage, especially to young palms, by the rhinoceros beetle is giving rise to concern, and it is obvious that any large-scale replanting programme with coconuts in this areas would meet with grave difficulties owing to beetle damage.

Coffee

The new coffee trial at the Federal Experiment Station, Jalan Kebun, suffered from drought during the quarter, but the onset of rain was followed by improved growth, which was most marked in the plots receiving a high level of potash.

The price at Klang of dried Liberian coffee beans at the end of aMrch was $135 a *picul*, a fall of $15 per *picul* over the quarter.

Cacao

During a three day visit to the Federal Experiment Station, Jerangau, a series of investigations on cacao die-back were carried out. Complete macroscopic and microscopic examination of seven trees, six of

them exhibiting die-back symptoms, were made and isolations were done on the spot on agar media. Wherever die-back was present the affected shoots or branches were always discoloured, but roots, stem bases, stems, healthy branches and shoots were unaffected. Fungi were isolated from diseased regions of stems but no one fungus was obtained in culture consistently, discounting the hypothesis that a pathogen is responsible for the disease. One or two species of Fusarium were isolated from two trees. Evidence of malnutrition as judged from leaf symptoms was seen on two of the seven trees.

The fungi, *Fusarium decemcellulare* and *Botryodiplodia theobromae* are in some obscure way connected with the die-back of cacao trees at the F.E.S., Serdang. It is possible that previous attempts to induce die-back by inoculations failed, not because of the fungi tested, but because the inoculum potential was too low. In a preliminary trial, the inoculum potential was increased by infecting the chloroform killed three inches of the apical region of the stem with the two fungi. It was assumed that the freshly killed stem tissue would be an ideal substrate for fungus growth and multiplication, and that the resulting high inoculum potential would enable it to breakdown the resistance of the healthy stem. Care was taken to ventilate, for a sufficient period, the killed stem before inoculating, in order to dispel any of the residual toxic substance.

In order to investigate 'seedling wilt' of young cacao a 64 pot factorial experiment using eight different nutrients in various combinations was laid down last December. The plants grew very well but symptoms of nutritional disorder quickly appeared in a high proportion of the pots. The symptoms were very similar to the leaf scorch obtained in sand culture experiments and ascribed to calcium deficiency. One plant from each pot was harvested eleven weeks after planting out and the weights of fresh leaves and stem were measured. Statistical analysis showed that P,K,L,PL and NL had highly significant positive effects on growth.

Existing field trials were maintained. Incidence of die-back, while it showed the normal seasonal increase, has been less serious than in 1957. This, it is thought, is due to the relatively light precipitation of rain during the monsoon, with consequent reduction in the quantity of bases lost by leaching. Routine use of limestone is also no doubt improving the situation.

Investigation of the value of chemicals for weed eradication indicated that sodium chlorate was suitable for use but that the sodium salt of 2.2 dichloropropionic acid (Dalapon) was harmful at concentrations as low as 10 lb. per acre.

Pineapple

The decline in the acreage of smallholder pineapples for canning purposes continued in the first quarter, and as long as there is no recovery in the price of fruit for canning, the decline is likely to continue and

accelerate. The pineapple cannery in Selangor changed hands during the quarter, and it is hoped that it will resume canning smallholder pineapples in the near future.

Fruit

A rambutan rootstock investigation is being carried out at the Federal Experiment Station, Serdang, in which illegitimate seedlings from specified clonal mother trees are being budgrafted with scions of known varieties.

Seedlings of various species of local and imported citrus intended for formal rootstock trials have been transplanted into stock beds at the F.E.S., Serdang. Growth of trees in a formal grapefruit variety trial at the Federal Experiment Station, Gajah Mati, Kedah, has improved as a result of a new spraying programme recently adopted.

Fruit Preservation

Samples of rambutan were analysed on the day received and after two and three days storage, in order to find if any change in chemical composition had developed on storage. Three lots of fruit were examined in this way for soluble solids, total sugars, reducing sugars, acidity and pH. Little change in chemical composition took place on storage, but on holding for three days or longer at room temperature the fruit became inedible due to decomposition.

Chemical analyses included determinations of soluble solids, total sugars, acidity and pH. All samples were tested by a panel in the laboratory and in each case this was compared with the figures for the chemical analysis. No relationship was found between the taste and results of chemical analysis.

Tea

The importance of nitrogenous fertiliser in inducing high yield on hill tea, continues to be shown in the second cycle of a manurial trial at the Federal Experiment Station, Cameron Highlands. Yield increases in response to application of nitrogen in the presence of limited phosphate and potash were highly economic.

Investigations of an improved technique involving the use of polyethylene sheet for vegetative propagation have been carried out and appear promising. Blocks of clonal and seedling tea have been planted in observation plots on deep peat soil at the Federal Experiment Station, Jalan Kebun.

Foodcrops

A potato variety trial designed to test the yield capacity and disease resistance of seven imported Dutch varieties with local material has been laid down at the F. E. S., Cameron Highlands. The last of a series of hybrid maize variety trials was laid down at the F. E. S., Serdang.

Livestock

It has been shown at the Federal Experiment Station, Serdang, that Bali steers, stall fed and provided with an adequate protein supplement, will put on a liveweight increase in the region of 1 lb. per day.

Pastures & Fodders

Selection of the more promising varieties under observation at the Federal Experiment Station, Kuala Lumpur, has continued. Analysis of the second year results of a manurial trial at the F.E.S., Serdang, shows that farm yard manure as well as nitrogen and potash are important in procuring continued high yield of guinea grass.

Soil Survey

No systematic dryland soil surveys were carried out during the quarter, since all the soil survey staff were employed on padi soil surveys in Kedah and Perlis. However, soil sampling has been carried out in a number of areas, notably the Ayer Hitam development area of Negri Sembilan, the proposed extension to the development area at Kemendore, Malacca, the area proposed for development as a smallholders oil palm scheme near Kulai, Johore and the proposed Drainage Scheme at Kampong Jawa, Endau, Pahang.

During the latter part of the quarter, the first course of instruction in dryland soil survey methods was given to six Agricultural Assistants from various States by the Soils Geologist. The object of this course is to provide each State with at least one A.A. capable of carrying out inspection and soil sampling of small areas proposed for development, etc.

Field work on the padi soil survey was re-started in mid-February and continued until the end of March, when wet weather made further work impracticable. Very good progress was made and the soil survey of the Kedah/Perlis coastal plain is now virtually complete, apart from some 14,000 acres in the districts of Yen and Dulang where difficulty of access to tractors, and off-season cropping, retarded the rate of progress. Some checking of soils boundaries still remains to be done and it is estimated that a further three weeks' field work will be required in the 1960 season. During the present field season the survey covered some 150,000 acres, some 400 miles of traverse lines being put in, generally at a spacing of about ¼ mile and with inspection pits at intervals of 200 yards. Within the Kedah/Perlis *gelam* * areas such close coverage was not possible but traverses made through the *gelam* have established that the *gelam* forest does in fact occupy an exceptionally uniform area of soil which has been classified as Kampong Telok series. This soil is characterised by a black, rather peaty, friable topsoil, very strong medium to coarse sub-angular blocky structure and a matrix colour which varies from light grey to brownish grey (in the 'acid phase'). Iron oxide deposits along root channels and structure faces are heavy and the subsoil is generally highly acidic.

* Swamp, characterised by the presence of the '*gelam*' tree.

Pests and Diseases

Attacks of *Hidari irava* Moore and *Artona catoxantha* Hamps on coconuts were reported from Kelantan and *Setora nitens* Walk from Telok Anson, Perak. An experiment to discover the most effective insecticide against a Tortricid larvae which was causing extensive damage to citrus was started at Subang Intan. Coccids, which were identified as *Asterolecanium* sp. were found to be attacking durian in Perak.

Education

Rural Training Centres in all States of the Federation were in operation throughout the quarter. The popularity of the courses provided continues to increase, and it is becoming difficult to cope with the flood of applications from farmers who wish to attend the course. In some States courses for women have been provided, and these have been especially popular. It is evident that the training facilities at present available will have to be considerably increased, although with the present acute shortage of Agricultural Assistants and Agricultural Officers this may not be immediately possible.

The use of demonstration plots as an extension technique has expanded very rapidly over the past year, and is now firmly established, with a wide range of crops covered. The demonstrations are popular and very effective.

STAFF NOTES

(Period 1st January to 31st March, 1959)

Honours and Awards

Mr. T. R. Dickinson, State Agricultural Officer, Perak, and Enche Tak bin Haji Daud, Agricultural Development Officer, Taiping, were awarded the Pingat Jasa Kebaktian, by H.H. the Sultan of Perak on the occasion of His Highness's 69th birthday.

Appointments

Zawawi bin Hamzah (Pupil Agricultural Officer)	....	Agricultural Officer, Perak North	21. 1.59

Promotions

The following promotions have been approved:—

Name and Rank		*Promoted to*		*Date*
T. R. Dickinson, P.J.K. (Agricultural Officer)	....	Senior Agricultural Officer, Grade B and	....	13.10.57
		to Grade A	....	1. 3.58
P. Class, (Agricultural Officer)	....	Senior Agricultural Officer, Grade B and	....	1. 3.58
		to Grade A	....	29. 3.58
J. S. Ure, (Agricultural Officer)	....	Senior Agricultural Officer, Grade B	....	29. 3.58
A. R. McWalter, (Senior Research Officer, Grade B.)	....	Senior Research Officer, Grade A		7.12.58
Muhammad bin Arshad, (Agricultural Asst.)	....	Assistant Agricultural Officer	....	1.11.58
Tak bin Haji Daud, P.J.K. (Assistant Research Officer)		Agricultural Development Officer		1. 1.58

Retirement

The following officer proceeded on leave prior to retirement under the Tenth Schedule to the Federation of Malaya Agreement (Amendment No. 4) Ordinance, 1956:—

Name and Rank		*Appointment*		*Date*
J. Dore	....	Plant Physiologist	....	28. 2.59

Leave

The following officer returned from leave:—

Name and Rank				
R. J. R. Barrett	....	Agronomist	....	14. 3.59

STATISTICS

October to December, 1958

Rubber.—The price of rubber, as quoted by the Singapore Chamber of Commerce Rubber Association, remained above the 80 cents level during the period. The average prices for the quarter were: International Type 1 (R.S.S.1) October, 87.92, November, 89.91, December, 83.27 cents per pound f.o.b.

The market has shown a fairly steady upward movement during the year and seems likely to remain strong. The industrialisation of China opens up the prospect of a greatly increased demand for natural rubber, and this increasing demand is developing at a time when Indonesia, China's normal source of supply, is falling short in her production through the disruption of her rubber estates and communications.

Malayan production for both estates and smallholders reached the highest point of the year in December, when a total for the month of 71,000 tons was produced. Of this total, smallholders production was approximately 30,000 tons. Total production for 1958 in the Federation was 661,000 tons, an increase of 24,000 tons over 1957 and 36,000 tons over 1956. (Table II).

Copra and Coconut Oil.—A comparison of the exports of coconut oil and copra between the years 1955-58 in Table VIII reveals the serious reduction in the supply of coconut products during the period. In 1956, 103,000 tons of oil were exported; in 1958, this had fallen to 67,000 tons. These figures are for Singapore and the Federation and reflect the reduction in supplies from Indonesia. However, a proportion of this loss in exported coconut oil must be attributed to a lower level of production from palms in the Federation, due to obsolescence. Smallholders production of copra dropped by 17,000 tons to 77,000 tons in the Federation in 1958, from a total of approximately 94,000 tons in 1957. Estate production fell by 1,000 tons during the year (Table VI).

Table I

AVERAGE MONTHLY PRICES PAID BY LOCAL DEALERS FOR SMALLHOLDERS' RUBBER, OCTOBER TO DECEMBER, 1958
(dollars per pikul*)

Grades	Alor Star, Kedah			Seremban, Negri Sembilan			Johore Bahru, Johore		
	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
Smoked Sheet No. 1	100.28	101.94	94.82	99.99	101.01	94.65	99.94	100.75	94.17
Smoked Sheet No. 3	93.70	94.91	90.11	93.87	95.12	90.63	94.90	95.45	90.90

* 1 pikul = 133⅓ lb.

This table has been compiled from statistics supplied by the Chief Statistician, Federation of Malaya.

Table II

RUBBER PRODUCTION
FEDERATION OF MALAYA

(long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1957	1958	1957	1958	1957	1958
January -	36,070	35,800	27,184	25,400	63,260	61,200
February -	27,002	28,800	21,998	22,900	49,000	51,700
March -	25,908	28,400	20,915	20,300	46,823	48,700
April -	26,501	26,600	22,460	18,200	48,961	44,800
May -	27,129	27,200	18,305	18,100	45,434	45,300
June -	29,628	31,200	21,583	21,800	51,211	53,000
July -	32,405	36,500	24,054	23,700	57,459	60,200
August -	32,957	34,000	23,119	24,600	56,076	58,600
September -	31,418	33,700	21,374	23,500	52,792	57,200
October -	33,290	35,000	22,462	23,000	55,752	58,500
November -	34,369	32,000	22,594	20,000	56,963	52,000
December -	32,390	41,000	21,976	30,000	54,366	71,000
Total -	369,073	390,200	268,024	271,500	637,097	661,300
Total 1956 -	352,233		273,368		625,601	

This table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.

Production on smallholdings (estates of less than 100 acres) is taken as the total of purchases from smallholders reported by licensed dealers.

Table III

AVERAGE PRICES PAID IN LONDON FOR TEA

(s.d. per lb.)

For the Week Ending	Malayan		Ceylon		Indonesian		India				Africa	
							Northern		Southern			
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
2.1.59	3	6.78	4	11.11	2	9.66	4	3.70	3	7.49	3	1.95
9.1.59	3	1.98	4	8.36	2	9.40	4	1.66	3	5.79	3	1.32
16.1.59	2	11.64	4	5.54	2	9.84	4	2.87	3	4.20	2	11.87
23.1.59	3	10.08	4	4.79	2	10.27	4	2.47	3	5.07	3	2.14
30.1.59	3	7.54	4	3.47	2	11.53	4	1.80	3	4.35	3	2.29
6.2.59	3	7.11	4	3.68	2	11.45	4	1.50	3	4.98	2	11.22
13.2.59	3	5.44	4	8.01	3	1.95	4	1.92	3	4.90	3	1.68
20.2.59	3	0.84	4	7.31	3	2.37	4	2.98	3	5.44	3	1.77
27.2.59	3	10.30	4	9.96	3	2.74	4	3.56	3	5.42	3	1.86
6.3.59	4	7.80	4	10.10	3	2.78	4	3.62	3	5.04	3	1.61
13.3.59	3	4.85	4	9.88	3	2.80	4	3.63	3	5.39	2	11.27
20.3.59	4	0.37	4	9.45	2	8.54	4	2.22	3	5.87	3	0.04
26.3.59	3	3.68	4	11.18	2	6.50	4	2.93	3	5.89	3	0.86

Table IV

AVERAGE DEALERS' PRICES FOR DRIED LIBERICAN COFFEE BEANS GROWN IN SELANGOR*

(dollars per pikul †)

For the Week Ending	Klang	Kuala Langat
	$	$
3-1-59	145.00	145.00
10-1-59	145.00	144.00
17-1-59	145.00	144.00
24-1-59	145.00	145.00
31-1-59	145.00	145.00
7-2-59	145.00	145.00
14-2-59	145.00	145.00
21-2-59	145.00	144.00
28-2-59	139.00	135.00
7-3-59	142.00	139.00
14-3-59	144.00	140.00
21-3-59	138.00	137.00
28-3-59	135.00	135.00

* These are not the prices paid to smallholders, who sell freshly harvested berries to dealers for processing.

† 1 pikul = 133⅓ lb.

Table V

PRODUCTION OF PALM OIL AND KERNELS AND PRICES OF PALM OIL

(long tons, as declared by estates)

Month	Production of Palm Oil (long tons)		Production of Palm Kernels (long tons)		Average Price per Ton of Palm Oil *		
	1957	1958	1957	1958	1958		
					£	s.	d.
January -	3,527	3,581	921	981	77	14	0
February -	3,572	4,460	926	1,192	78	2	0
March -	4,828	6,090	1,225	1,645	80	7	0
April -	4,585	5,748	1,168	1,552	78	14	0
May -	4,689	5,609	1,096	1,408	78	17	0
June -	5,140	5,782	1,203	1,398	74	15	0
July -	5,823	7,243	1,480	1,874	72	10	0
August -	5,355	6,939	1,445	1,832	69	5	0
September -	5,666	6,952	1,408	1,800	66	16	0
October -	5,896	5,825	1,465	1,523	68	1	0
November -	5,070	5,517	1,341	1,452	68	2	5
December -	5,356	5,925	1,103	1,616	70	9	5
Total -	58,507	69,671	14,781	18,273			

* F.O.B.

Table VI

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE FEDERATION OF MALAYA

(tons)

Month	Copra Production						Coconut Oil Production *		Copra Cake (Poonac) Manufactured	
	Estates		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1957	1958	1957	1958	1957	1958	1957	1958	1957	1958
January	2,473	2,449	8,454	1,857	10,927	4,306	8,272	8,164	5,160	5,136
February	2,339	2,546	5,916	8,100	8,255	10,646	7,919	5,458	4,803	3,397
March	2,725	2,895	5,510	7,028	8,235	9,923	8,677	7,032	5,340	4,469
April	2,848	2,910	6,975	8,421	9,824	11,331	6,618	6,032	4,245	3,905
May	3,098	3,275	8,185	11,123	11,283	14,398	6,614	7,223	4,163	4,690
June	3,513	3,431	7,235	3,447	10,748	6,878	8,541	7,485	5,405	4,886
July	4,105	3,985	10,456	8,572	14,561	12,557	8,879	7,828	5,649	5,183
August	3,488	3,575	10,865	9,200	14,353	12,775	8,775	7,168	5,528	4,669
September	3,195	2,769	7,948	5,400	11,143	8,169	8,704	7,168	5,470	4,620
October	2,880	2,519	9,935	6,000	12,815	8,519	9,174	6,939	5,753	4,472
November	2,591	2,134	5,285	4,000	7,876	6,134	8,347	4,351	5,231	2,805
December	2,587	2,332	7,671	4,000	10,258	6,332	5,988	3,703	3,941	2,442
Total	35,843	34,820	94,435	77,148	130,278	111,968	96,508	78,551	60,688	50,674

Notes:—1. The above table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills, respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

* Includes both refined and crude oil.

Table VII

SINGAPORE PRICES OF VARIOUS AGRICULTURAL PRODUCTS

(dollars per pikul †)

Date	Copra, Sundried	Coconut Oil *	Pepper, F.A.Q. Muntok White	Pepper, Gen. Muntok White	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
5-1-59	39.75	63.00	129.00	139.00	45.00	9.75	17.75	17.50
12-1-59	40.75	67.00	*29.00	139.00	46.00	9.75	17.50	18.50
2-2-59	42.45	67.50	142.00	152.00	46.00	9.37	17.00	17.50
11-2-59	42.25	67.50	144.50	154.50	45.00	9.37	17.00	17.00
23-2-50	42.50	67.00	149.00	159.00	46.00	9.37	17.00	17.50
2-3-59	42.75	67.00	156.00	166.00	45.00	9.25	17.00	18.00
9-3-59	43.00	67.00	159.00	169.00	45.00	9.25	17.00	18.50
16-3-59	43.50	67.00	163.00	173.00	46.00	9.25	18.00	18.50
31-3-59	43.00	67.00	154.00	164.00	46.00	9.00	18.00	17.50
6-4-59	43.25	67.00	154.00	164.00	46.00	9.00	17.00	17.50
13-4-59	44.00	69.00	154.00	164.00	46.00	8.50	17.00	17.00
21-4-59	46.50	71.00	152.00	162.00	46.00	8.62	17.00	16.75
27-4-59	44.50	70.00	146.00	156.00	46.00	8.62	17.00	16.50

† 1 pikul = 133⅓ lb.

* F.O.B. in second-hand drums.

‡ Nominal.

The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

Table VIII

MALAYAN AGRICULTURAL EXPORTS, JANUARY TO DECEMBER, 1958. ‡

Product	Net Exports in Tons			
	Year 1955	Year 1956	Year 1957	Year 1958
Arecanuts	13,679	11,228	9,625	4,938
Coconuts, fresh †	72,140	34,779	37,466	52,340
Coconut oil	91,176	103,132	100,031	67,483
Copra	75,076 *	82,549 *	71,718 *	55,906 *
Copra cake	56,404 *	66,174 *	73,208 *	72,453 *
Gambier, all kinds	66	96	209	555
Palm Oil	52,832	55,252	56,728	67,818
Pineapples, canned	27,756	30,377	37,671	41,417
Sago, flour	23,053	21,483	15,581	21,652
Sago, pearl	5,483	4,276	4,021	3,104
Sago, raw	18,709 *	18,522 *	14,006 *	13,383 *
Tapioca, flake	475	260	403	350
Tapioca, flour	3,979 *	3,753 *	1,573 *	1,920 *
Tapioca, pearl	5,470	5,630	5,222	3,333

† hundreds. * net imports.

‡ Statistics compiled from "External Trade of Malaya" (Colony of Singapore and Federation of Malaya) December, 1958.

METEOROLOGICAL SUMMARY, MALAYA, NOVEMBER, 1958

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes				At 4	At 1				Number of Days							
	A.	B.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	foot	feet	Total	Most in a day		Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
	Max.	Min.						° F	° F		Amt.									
Ipoh, Perak	89.6	72.4	81.6	93.0	65.2	80.3	75.9			12.38	314.5	4.75	18	15	3			175.05	5.83	
Kuala Lumpur, Selangor	88.8	73.6	81.2	92.3	69.0	82.7	75.7			10.78	273.8	2.07	25	20	13	5		152.95	5.10	
Sitiawan, Perak	87.0	72.5	79.7	90.3	66.3	80.2	75.5	82.9	84.9	7.93	201.4	1.82	16	14	1	2		171.50	5.72	
Kuantan, Pahang	84.4	72.1	78.3	91.3	66.2	76.3	74.3	80.7		11.10	281.9	1.40	23	21				113.90	3.80	
Bayan Lepas, Penang	86.8	73.4	80.1	90.2	67.0	78.4	76.4			10.45	265.4	3.67	22	17	7			185.50	6.18	
Malacca	86.9	73.6	80.3	90.3	71.2	82.3	75.2			19.42	493.3	4.47	22	21	3	1		122.05	4.07	
Mersing, Johore	84.0	72.5	78.3	87.4	70.3	78.0	76.8			15.37	390.4	2.61	24	23			1	120.50	4.02	
Alor Star, Kedah	87.5	73.8	80.7	92.2	64.4	78.9	75.9			9.08	230.6	2.39	15	11	1			187.15	6.24	
Kota Bharu, Kelantan	82.0	73.1	77.5	86.8	66.0	76.0	77.0	78.0	78.4	42.14	1070.4	7.06	26	25	5		2	114.05	3.80	
K. Trengganu, Trengganu	83.3	73.1	78.2	89.1	67.9	76.1	75.6			29.86	758.4	5.32	26	24		1		125.35	4.18	
Singapore	86.9	74.5	80.7	89.4	71.3	83.0	77.3			13.77	349.8	2.05	23	18	14			120.55	4.02	
HILL STATIONS																				
Cameron Highlands, Tanah Rata, Pahang. (3750 ft.)	72.3	55.3	63.8	77.6	43.0	66.6	62.2			8.58	217.9	2.05	19	16				119.20	3.97	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, DECEMBER, 1958

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	9.25	71.5	82.0	95.2	67.2	90.0	74.6			2.70	68.6	0.95	9	6	2			237.40	7.66	
Kuala Lumpur, Selangor	90.7	72.3	81.5	92.4	69.2	86.8	74.4			6.78	172.2	1.89	15	12	7	7		208.95	6.74	
Sitiawan, Perak	88.6	71.9	80.3	91.0	68.2	85.0	74.2	83.0	84.3	5.59	412.0	2.85	11	8	1	2		218.65	7.05	
Kuantan, Pahang	84.3	70.3	77.3	87.6	67.0	78.2	74.0	79.4		4.52	114.8	2.78	18	15				158.55	5.11	
Bayan Lepas, Penang	89.6	73.3	81.5	93.0	69.3	87.3	76.1			1.41	35.8	0.70	6	6	1			275.90	8.90	
Malacca	88.9	72.9	80.9	91.8	68.9	84.8	76.0			1.52	38.6	0.82	7	5	1		1	226.35	7.30	
Mersing, Johore	82.7	74.7	78.7	84.6	70.8	78.8	77.8			14.41	35.6	6.24	15	11				182.45	5.89	
Alor Star, Kedah	89.7	70.9	80.3	94.2	66.7	85.2	74.2											290.35	9.37	
Kota Bharu, Kelantan	88.9	73.1	78.5	86.0	68.3	79.1	77.6	80.7	81.2	3.46	87.9	1.02	15	9		2		184.05	5.94	
K. Trengganu, Trengganu	83.1	73.2	78.1	84.6	69.3	79.7	77.0			5.18	13.16	3.58	16	11		4		191.10	6.16	
Singapore	86.7	74.1	80.4	88.0	71.2	78.0	75.6			4.32	109.7	1.54	12	11	3			203.35	6.56	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	72.0	54.0	63.0	74.8	45.0	70.0	62.0			1.64	41.7	0.76	11	10				118.85	3.83	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JANUARY, 1959

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of		Means of A and B	Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.		Highest Max.	Lowest Min.	Lowest Max.	Highest Min.					Amt.	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
								o F	o F	in.	mm.	in.						hr.	hr.	
Ipoh, Perak	93.1	72.2	82.7	98.3	68.0	87.1	75.3			3.66	93.0	1.51	11	9	2			247.25	7.97	
Kuala Lumpur, Selangor	90.5	71.9	81.2	94.2	67.3	84.1	74.6			2.58	65.5	1.61	10	9	2	3		223.40	7.21	
Sitiawan, Perak	89.3	72.3	80.8	92.8	69.0	85.2	74.9	83.5	84.6	7.15	181.6	2.54	13	10	2	4		235.20	7.59	
Kuantan, Pahang	84.5	70.8	77.7	88.0	64.4	79.3	74.5	79.5		9.09	230.9	2.09	18	16				174.20	5.62	
Bayan Lepas, Penang	91.8	73.9	82.9	96.1	70.8	89.0	77.2			0.40	10.2	0.21	3	3	1			284.30	9.17	
Malacca	88.8	73.1	80.9	73.9	69.2	76.8	76.4			1.30	33.0	0.41	8	6			4	214.05	6.90	
Mersing, Johore	82.2	74.5	78.3	84.5	70.4	79.1	72.8			11.67	296.4	4.47	17	13			7	144.20	4.65	
Alor Star, Kedah	91.4	70.9	81.1	94.6	67.6	82.1	74.5			0.08	2.0	0.07	2	1				295.90	9.55	
Kota Bharu, Kelantan	84.4	72.9	78.7	86.8	68.2	82.2	78.2	83.3	83.8	2.29	58.2	1.17	13	10		1		213.35	6.88	
K. Trengganu, Trengganu	83.1	72.7	77.9	84.3	69.0	80.2	76.7			4.19	106.4	1.66	20	13				191.30	6.17	
Singapore	85.1	74.0	79.5	88.8	71.4	78.4	77.3			7.20	182.9	1.92	20	14				150.25	4.85	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	71.2	55.2	68.2	74.6	46.0	66.8	62.0			1.36	34.5	0.32	13	10				164.05	5.28	

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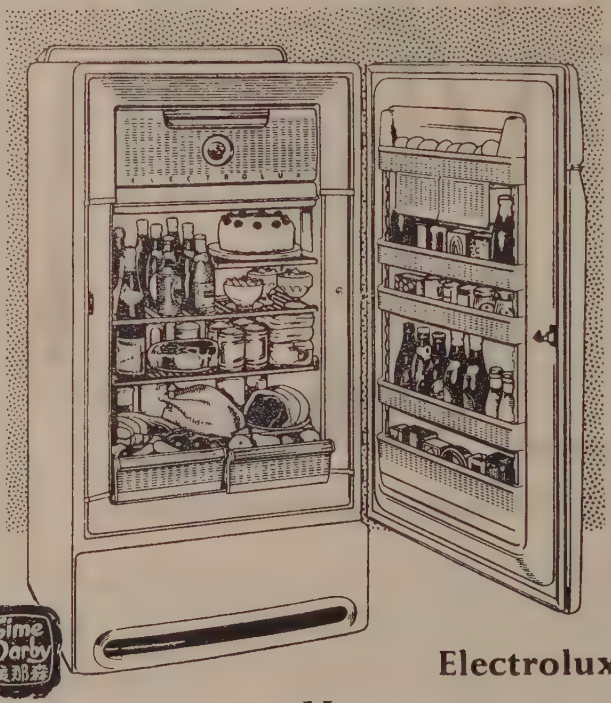

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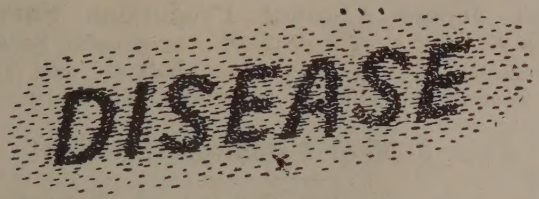

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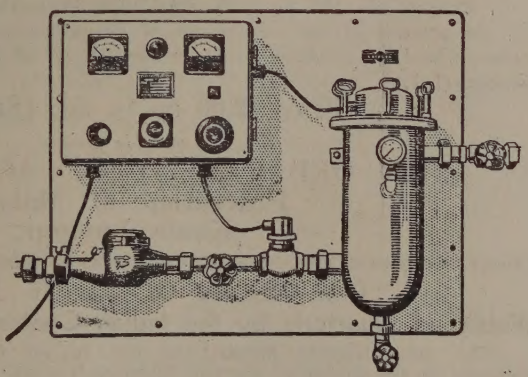

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DEPARTMENT OF AGRICULTURE, FEDERATION OF MALAYA.

The Director of Agriculture invites those interested to visit the College of Agriculture, Serdang, Selangor, and the various Federal and State Stations throughout the Federation Malaya. Intending visitors to the College of Agriculture should communicate with the Principal; to the Federal Experiment Station, Serdang, Selangor, with the Agronomist-in-charge; and to other Federal and State Stations with the State Agricultural Officers. The following is a list of Agricultural Stations on which can be studied the more important lines of investigation and extension at present carried out by the Department.

Correspondence concerning the experiments at any of these Stations should, if it originates in Malaya, be addressed to the State Agricultural Officer, concerned; correspondence originating in any other country should be addressed to the Director of Agriculture, Federation of Malaya, Kuala Lumpur.

Wet Padi.

SELECTION WORK. Telok Chengai, Kedah; Titi Serong, Simpang Tiga and Talang, Perak; Pulau Gadong, Malacca; Kota Bharu and Jelawat, Kelantan; Kendong, Ulu Klawang and Ampang Tinggi, Negri Sembilan; Tangkak, Johore; Genting and Bukit Merah, Penang and Province Wellesley; and other State Stations.

AGRONOMIC INVESTIGATIONS. Most Padi Experiment and Test Stations.

PADI MECHANISATION SCHEME, Parit, Perak.

Dry Padi.

Melor, Kelantan, and Paya Besar, Pahang.

Rubber.

Budwood and clonal seedling nurseries. Most State Agricultural Stations. Replanting demonstration plots in all States.

Tea.

Federal Experiment Stations, Cameron Highlands and Serdang.

Oil Palm.

Federal Experiment Stations, Serdang, Selangor, and Jerangau, Trengganu.

Coconut.

Federal Experiment Station, Telok Bharu, Perak, and Coconut (Rehabilitation) Station, Sungei Sudah, Muar, Johore.

Cacao.

FEDERAL EXPERIMENT STATIONS. Serdang, Selangor, and Jerangau, Trengganu.

AMELONADO SEED GARDENS. Sik, Kedah; Batang Merbau, Kelantan; Ayer Itam, Penang; Layang Layang Kiri and Bukit Gantang, Perak; Temerloh, Kuala Lipis and Pekan, Pahang; Ampang Tinggi, Negri Sembilan; Sungei Udang, Malacca; Ayer Hitam, Tangkak, Johore; Sungei Tong, Trengganu.

Pineapple.

Jalan Kebun, Selangor, and Alor Bukit, Johore.

Manila Hemp.

Federal Experiment Station, Serdang, Selangor; Degong, Perak; and Sungei Ruan, Pahang.

Fruit Propagation.

Federal Experiment Station, Serdang, and all State Agricultural Stations.

Vegetables.

Federal Experiment Stations, Kuala Lumpur and Cameron Highlands.

Poultry.

Federal Experiment Station, Cameron Highlands and most State Agricultural Stations.

Livestock.

PIGS: Federal Experiment Stations, Serdang and Cameron Highlands; Sungei Buloh and Jenjarom, Selangor; Mah San, Negri Sembilan; Raja Hitam (Dindings) and Teluk Bharu, Perak; Pulau Gadong, Malacca; and Ayer Itam, Penang.

GOATS: Ayer Itam, Penang; Bukit Mertajam, Province Wellesley; Sungei Udang, Malacca; Cheras, Setapak, Sabak Bernam and Federal Experiment Station, Serdang, Selangor; Chembong, Negri Sembilan.

Pastures.

Federal Experiment Station, Serdang, Selangor.

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